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Preface

The complex behavior of systems in nature is rooted in intricate mechanisms of interactions that, although having factors in common with human-made systems of computation, often supersede them in terms of reliability, power efficiency, and computational capacity. It is thus no surprise that natural systems have become the inspiration of novel algorithms that are based on nonstandard computational mechanisms.

The International Workshop on Natural Computing (IWNC) is focused on theoretical and experimental studies of nature-inspired principles of information processing, novel and emerging paradigms of computation and computing architectures, and case studies of simulated or real-world computing devices implemented in biological, social, chemical, engineering and physical systems. Topics include cellular automata, DNA computation, the physics of computation, computation in living cells, nanocomputing, artificial chemistry, swarm systems, evolutionary computing, reaction-diffusion processors, plasmodium computers, neural networks, chaotic systems, noise-driven computation, and others.

The goal of the IWNC is to offer computer scientists, biologists, mathematicians, electronic engineers, physicists, and social scientists a platform to critically assess present findings in the field, and to outline future developments in nature-inspired computing.

This year's workshop hosted, for the first time, a special session on Unconventional Models of Communication. The reason for this is that the characteristics making natural systems so interesting for computation also offer important hints for the design of communication systems. A fundamental research challenge in this context is the design of robust decentralized communication systems capable of operating in changing environments with noisy input.

IWNC is organized annually and the details of the past three meetings are as follows:

- December 14-15, 2006: University of the West of England, Bristol, UK
- December 10-13, 2007: Nagoya University, Nagoya, Japan
- September 23, 2008: Yokohama National University, Yokohama, Japan

The latest workshop, held in Himeji, Japan, September 23-25, 2009, brought together more than 70 distinguished researchers (from more than 15 countries) with a wide variety of backgrounds working in the field of natural computing. The workshop involved the cooperation between the institutions of the members of the organizing committee, i.e., the National Institute of Information and Communications Technology (NICT), Osaka Electro-Communication University, and the University of Hyogo, Himeji, all located in Japan.

This volume contains 19 refereed papers for oral presentation, and 14 refereed papers for poster presentation, as well as four invited papers and six papers from invited speakers of worldwide reputation. The special session on Unconventional Models of Communication included one invited talk (by Masayuki Murata) and

two presentations (by Sasitharan Balasubramaniam et al. and by Yuki Moritani et al.) as part of the invited papers. The special session was organized by Naoki Wakamiya and Kenji Leibnitz, both from Osaka University in Japan, and we would like to express our gratitude for their efforts in making it a great success.

Each paper was reviewed by three members of the program committee. We are extremely grateful to the reviewers, whose expertise and efficiency guaranteed the high quality of the workshop.

We would like to take this opportunity to express our sincere thanks to the invited speakers and the presenters of invited papers for having accepted our invitations to present their research. The invited speakers were:

- Anirban Bandyopadhyay of the National Institute of Materials Science (NIMS; Japan)
- Laszlo B. Kish of Texas A&M University (USA)
- Bruce J. MacLennan of the University of Tennessee (USA)
- Masayuki Murata of Osaka University (Japan)
- Toshio Nakagaki of Hokkaido University (Japan)
- Milan N. Stojanovic of Columbia University (USA)

The presenters of invited papers were:

- Sasitharan Balasubramaniam of the Waterford Institute of Technology (Ireland)
- Andrew Kilinga Kikombo of Hokkaido University (Japan); paper not included in this proceedings
- Jia Lee of NICT (Japan) and Chong-Qing University (China)
- Yuki Moritani of NTT DoCoMo (Japan)
- Manish Dev Shrimali of the LNM Institute of Information Technology (India)

We would like to thank those authors who showed interest in IWNC 2009 by submitting their papers for review. It is a pleasure to express our sincere thanks to our colleagues in the Program Committee and the International Steering Committee. This workshop would not have been possible without their help, advice, and continuous encouragement. We would also like to express our gratitude to Naotake Kamiura of the University of Hyogo in Japan, who provided us with valuable advice and support concerning the organization of the workshop.

Finally, the organization of IWNC 2009 was made possible thanks to financial and technical support from the National Institute of Information and Communications Technology (NICT), Osaka Electro-Communication University, the University of Hyogo in Himeji, the city of Himeji, the Himeji Convention & Visitors Bureau, the Support Center for Advanced Telecommunications Technology Research (SCAT), and the Society of Instrument and Control Engineers (SICE), all located in Japan.

November 2009

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4th IWNC (IWNC2009) Organization

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