Lecture Notes in Computer Science 6686

Commenced Publication in 1973
Founding and Former Series Editors:
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Foundations on Natural and Artificial Computation

4th International Work-Conference on the Interplay Between Natural and Artificial Computation, IWINAC 2011
La Palma, Canary Islands, Spain, May 30 - June 3, 2011
Proceedings, Part I

Springer

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ISSN 0302-9743 e-ISSN 1611-3349
ISBN 978-3-642-21343-4 e-ISBN 978-3-642-21344-1
DOI 10.1007/978-3-642-21344-1
Springer Heidelberg Dordrecht London New York

Library of Congress Control Number: Applied for

CR Subject Classification (1998): F.1, F.2, I.2, G.2, I.4, I.5, J.3-4, J.1

LNCS Sublibrary: SL 1 – Theoretical Computer Science and General Issues

Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface

Searching for the Interplay between Natural and Artificial Computation

The general aim of these volumes, continuing with ideas from Professor José Mira and with neurocybernetic concepts from Wiener and W.S. McCulloch, is to present a wider and more comprehensive view of the computational paradigm (CP), proposed by Alan Turing, than usual in computer science and artificial intelligence (AI) and to propose a way of using that which makes it possible: (1) to help neuroscience and cognitive science, by explaining the latter as a result of the former, (2) to establish an interaction framework between natural system computation by posing a series of appropriate questions in both directions of the interaction, from artificial systems to natural systems (in computational neuroscience), and from natural systems to artificial systems (in bioinspired computation). This is the main motivation of the International Work-conference on the Interplay between Natural and Artificial Computation, trying to contribute to both directions of the interplay:

I: From Artificial to Natural Computation. What can computation, artificial intelligence (AI) and knowledge engineering (KE) contribute to the understanding of the nervous system, cognitive processes and social behavior? This is the scope of computational neuroscience and cognition, which uses the computational paradigm to model and improve our understanding of natural science.

II: From Natural Sciences to Computation, AI and KE. How can computation, AI and KE find inspiration in the behavior and internal functioning of physical, biological and social systems to conceive, develop and build up new concepts, materials, mechanisms and algorithms of potential value in real-world applications? This is the scope of the new bionics, known as bioinspired engineering and computation, as well as of natural computing.

To address the two questions exposed in the scope of IWINAC 2011, we will make use of a wide and comprehensive view of the computational paradigm that first considers three levels of description for each calculus (physical mechanisms, symbols and knowledge) and then distinguishes between two domains of description (the level "own" domain and the domain of the external observer).

This wider view of the computational paradigm allows us more elbow room to accommodate the results of the interplay between nature and computation. The IWINAC forum thus becomes a methodological approximation (set of intentions, questions, experiments, models, algorithms, mechanisms, explanation procedures, and engineering and computational methods) to the natural and artificial perspectives of the mind embodiments problem, both in humans and in artifacts. This is the philosophy of the IWINAC meetings, the "interplay" movement between the natural and artificial, facing this same problem every

two years. We want to know how to model biological processes that are associated with measurable physical magnitudes and, consequently, we also want to design and build robots that imitate the corresponding behaviors based on that knowledge. This synergistic approach will permit us not only to build new computational systems based on the natural measurable phenomena, but also to understand many of the observable behaviors inherent to natural systems.

The difficulty of building bridges over natural and artificial computation was one of the main motivations for the organization of IWINAC 2011. In this edition, the conference was simultaneously coorganized with the Joint Workshop and Summer School: Astrostatistics and Data Mining in Large Astronomical Databases 2011, that aims to apply AI techniques to astronomical data. The IWINAC 2011 proceedings volumes include the 108 works selected by the Scientific Committee after a refereeing process. The first volume, entitled *Foundations on Natural and Artificial Computation*, includes all the contributions mainly related to the methodological, conceptual, formal, and experimental developments in the fields of neurophysiology and cognitive science. The second volume entitled *New Challenges on Bioinspired Applications* contains the papers related to bioinspired programming strategies and all the contributions related to the computational solutions to engineering problems in different application domains, especially health applications, including the CYTED "Artificial and Natural Computation for Health" (CANS) research network papers.

An event like IWINAC 2011 cannot be organized without the collaboration of a group of institutions and people, whom we would like to thank now, starting with *UNED* and *Universidad Politécnica de Cartagena*. The collaboration of the *UNED associated center* was crucial, as was the efficient work of the Local Committee, Francisco Javier Neris Paz and Juan Antonio González Arnaez, with the close collaboration of the *Instituto de Astrofísica de Canarias*, and the essential support of Rafael Rebolo and Juan Carlos Pérez. In addition to our universities, we received financial support from the Spanish *Ministerio de Ciencia e Innovación, CYTED, Red Nacional en Computación Natural y Artificial* and *APLIQUEM S.L.*

We want to express our gratefulness to our invited speakers, Changjiu Zhou from Singapore Polytechnic, Paul Cull, Oregon State University, Rüdiger Dillmann from Karlsruhe Institute of Technology (KIT) and Jon Hall, Open University, for accepting our invitation and for their magnificent plenary talks.

We would also like to thank the authors for their interest in our call and the effort in preparing the papers, condition *sine qua non* for these proceedings, and to all the Scientific and Organizing Committees, in particular, the members of these committees that have acted as effective and efficient referees and as promoters and managers of pre-organized sessions on autonomous and relevant topics under the IWINAC global scope.

Our sincere gratitude also goes to Springer and to Alfred Hofmann and his collaborators, Anna Kramer and Leonie Kunz, for the continuous receptivity, help, and collaboration in all our joint editorial ventures on the interplay between neuroscience and computation.

Finally, we want to express our special thanks to *ESOC S.L.*, our technical secretariat, and to Victoria Ramos, for making this meeting possible, arranging all the details that comprise the organization of this kind of event.

All the authors of papers in this issue, as well as the IWINAC Program and Organizing Committees, would like to pay tribute to the memory of Professor Mira, both as a great scientist and as a good friend. We still greatly miss him.

June 2011

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