

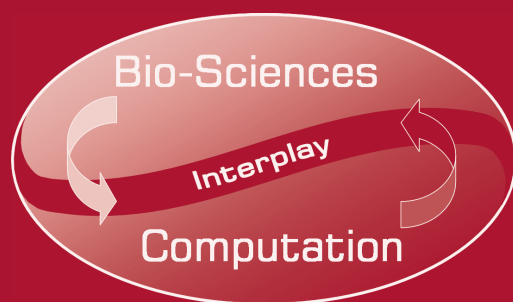
José Manuel Ferrández Vicente  
José Ramón Álvarez-Sánchez  
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Fco. Javier Toledo-Moreo  
Hojjat Adeli (Eds.)

LNCS 9107

# Artificial Computation in Biology and Medicine

International Work-Conference on the Interplay  
Between Natural and Artificial Computation, IWINAC 2015  
Elche, Spain, June 1–5, 2015, Proceedings, Part I

1  
Part I



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ISSN 0302-9743                      ISSN 1611-3349 (electronic)  
Lecture Notes in Computer Science  
ISBN 978-3-319-18913-0              ISBN 978-3-319-18914-7 (eBook)  
DOI 10.1007/978-3-319-18914-7

Library of Congress Control Number: 2015939151

LNCS Sublibrary: SL1 – Theoretical Computer Science and General Issues

Springer Cham Heidelberg New York Dordrecht London

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Printed on acid-free paper

Springer International Publishing AG Switzerland is part of Springer Science+Business Media  
(www.springer.com)

# Preface

The computational paradigm considered here is a conceptual, theoretical, and formal framework situated above machines and living creatures (two instantiations), sufficiently solid, and still non exclusive, that allows us:

1. to help neuroscientists to formulate intentions, questions, experiments, methods, and explanation mechanisms assuming that neural circuits are the psychological support of calculus;
2. to help scientists and engineers from the fields of artificial intelligence (AI) and knowledge engineering (KE) to model, formalize, and program the computable part of human knowledge;
3. to establish an interaction framework between natural system computation and artificial system computation in both directions, from Artificial to Natural and from Natural to Artificial.

With these global purposes, Prof. José Mira organized the 1st International Work Conference on the Interplay between Natural and Artificial Computation, which took place in Las Palmas de Gran Canaria, Canary Islands (Spain), 10 years ago, trying to contribute to both directions of the interplay.

Today, the hybridization between social sciences and social behaviors with robotics, neurobiology and computing, ethics and neuroprosthetics, cognitive sciences and neurocomputing, neurophysiology and marketing is giving rise to new concepts and tools that can be applied to ICT systems, as well as to natural science fields. Through IWINAC we provide a forum in which research in different fields can converge to create new computational paradigms that are on the frontier between Natural sciences and Information technologies.

As a multidisciplinary forum, IWINAC is open to any established institutions and research laboratories actively working in the field of this interplay. But beyond achieving cooperation between different research realms, we wish to actively encourage cooperation with the private sector, particularly SMEs, as a way of bridging the gap between frontier science and societal impact, and young researchers in order to promote this scientific field.

In this edition, four main themes outline the conference topics: gerontechnology and e-therapy, Brain–Computer Interfaces, Biomedical imaging applications for health, and artificial vision and robotics.

Gerontechnology is an interdisciplinary field combining gerontology and technology. Gerontechnology aims at matching systems to health, housing, mobility, communication, leisure, and work of the elderly. The development of computing systems for gerontechnology has turned into a challenging activity requiring disciplines as diverse as artificial intelligence, human–computer interaction, and wireless sensor networks to work together in order to provide solutions able to satisfy this growing societal demand.

Brain–Computer Interfaces implement a new paradigm in communication networks, namely Brain Area Networks. In this paradigm, our brain inputs data (external

stimuli), performs multiple media-access control by means of cognitive tasks (selective attention), processes the information (perception), takes a decision (cognition) and, eventually, transmits data back to the source (by means of a BCI), thus closing the communication loop. The objectives include neuro-technologies (e.g. innovative EEG/ECG/fNIRS headsets, integrated stimulation-acquisition devices, etc.), Tele-services (e.g. applications in Telemedicine, tele-rehabilitation programs, tele-control, mobile applications, etc.), innovative biosignal processing algorithms, training techniques, and novel emerging paradigms.

Image understanding is a research area involving both feature extraction and object identification within images from a scene, and a posterior treatment of this information in order to establish relationships between these objects with a specific goal. In biomedical and industrial scenarios, the main purpose of this discipline is, given a visual problem, to manage all aspects of prior knowledge, from study start-up and initiation through data collection, quality control, expert independent interpretation, to design and development of systems involving image processing capable of tackling with these tasks. Brain imaging using EEG techniques or different MRI systems can help in some neural disorders, like epilepsy, Alzheimer, etc.

Over the last decades there has been an increasing interest in using machine learning methods combined with computer vision techniques to create autonomous systems that solve vision problems in different fields. This research involves algorithms and architectures for real-time applications in the areas of computer vision, image processing, biometrics, virtual and augmented reality, neural networks, intelligent interfaces, and biomimetic object-vision recognition. Autonomous robot navigation sets out enormous theoretical and applied challenges to advanced robotic systems using these techniques.

Ten years after the birth of IWINAC meetings these ideas maintain the visionary objectives of Prof. Mira. This wider view of the computational paradigm gives 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 embodiment problem, both in humans and in artifacts. This is the philosophy that continues in IWINAC meetings, the “interplay” movement between the natural and the artificial, facing this same problem every two years. 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 between natural and artificial computation is one of the main motivations for the organization of IWINAC 2015. The IWINAC 2015 proceedings contain the works selected by the Scientific Committee from more than 190 submissions, after the refereeing process. The first volume, entitled *Artificial Computation in Biology and Medicine*, includes all the contributions mainly related to the methodological, conceptual, formal, and experimental developments in the fields of neural sciences and health. The second volume, entitled *Bioinspired Computation in Artificial Systems*, contains the papers related to bioinspired programming strategies and all the contributions related to the computational solutions to engineering problems in different application domains.

An event of the nature of IWINAC 2015 cannot be organized without the collaboration of a group of institutions and people who we would like to thank now, starting with UNED and Universidad Politécnica de Cartagena. The collaboration of the UNED Associated Center in Elche was crucial, as was the efficient work of the Local Organizing Committee, chaired by Eduardo Fernández with the close collaboration of the Universidad Miguel Hernández de Elche. In addition to our universities, we received financial support from the Spanish CYTED, Red Nacional en Computación Natural y Artificial and Apliquem Microones 21 s.l.

We want to express our gratefulness to our invited speakers Prof. Hojjat Adeli, Ohio State University (USA), Prof. Marc de Kamps, University of Leeds (UK), Prof. Richard Duro, University of A Coruña (Spain), and Prof. Luis Miguel Martínez Otero, University Miguel Hernández (Spain) 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. We thank the Scientific and Organizing Committees, in particular the members of these committees who acted as effective and efficient referees and as promoters and managers of preorganized sessions on autonomous and relevant topics under the IWINAC global scope.

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

Finally, we want to express our special thanks to Viajes Hispania, our technical secretariat, and to Chari García and Beatriz Baeza, for making this meeting possible, and for arranging all the details that comprise the organization of this kind of event. We want to dedicate these two volumes of the IWINAC proceedings to the memory of Professor Mira, whose challenging and inquiring spirit is in all of us. We greatly miss him.

June 2015

José Manuel Ferrández Vicente  
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