Preface

The hybridization between social sciences and social behaviors with robotics, neurobiology and computing, ethics and neuroprosthetics, cognitive sciences and neurocomputing, neurophysiology and marketing will give rise to new concepts and tools that can be applied to information and communication technology (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 neural 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 small and medium-sized enterprises (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, there were four main themes highlighting the conference topics: affective computing, signal processing and machine learning applied to biomedical and neuroscience applications, deep learning and big data, and biomedical applications.

Traditionally, when ICT research has been performed in relation to the human brain, the focus has been on the cognitive brain. Primary research in computer science, engineering, psychology, and neuroscience has been aimed at developing devices that recognize human affects and emotions. In computer science, affective computing is a branch of the study and development of artificial intelligence that deals with the design of systems and devices that can recognize, interpret, and process human emotions. It is an interdisciplinary field spanning computer sciences, psychology, and cognitive science.

Emotion recognition refers to the problem of inferring the significance of human expressions of different emotions. This inference is natural for human observers but is a non-trivial problem for machines. The data gathered on the cues humans use to perceive emotions in others may be used in machine-learning techniques. Emotional speech processing recognizes the user's emotional state by analyzing speech patterns. EEG analysis may also detect human emotions by studying the positive and negative peaks located in specific areas around 450 ms after stimulus induction. Another area within affective computing is the design of computational devices proposed to exhibit either innate emotional capabilities or that are capable of convincingly simulating emotions. Robots may be used for embodying personality traits that induce desired emotions in humans and behave in an appropriate manner when recognizing human emotional state. Neuroprosthetics may be used for treating emotional disorders by electrical stimulation of certain specific areas in the thalamus or other neural centers.

The increasing spread of in vivo imaging technologies, such as magnetic resonance imaging (MRI), diffusion tensor imaging (DTI), functional MRI (fMRI), single photon emission computed tomography (SPECT), positron emission tomography (PET) and other non-invasive techniques such as electroencephalography (EEG) or magnetoencephalography (MEG), have meant a breakthrough in the diagnosis of several pathologies, such as Alzheimer's disease, Parkinson's disease, etc. Today, signal processing and machine learning methods are crucial as supporting tools for a better understanding of diseases. In this way, signal processing and machine learning applied to biomedical and neuroscience applications became an emergent and disruptive field of research.

Deep learning has presented a breakthrough in the artificial intelligence community. The best performances attained so far in many fields, such as computer vision or natural language processing, have been overtaken by these novel paradigms to a point that only ten years ago was pure science fiction. In addition, this technology has been open sourced by the main artificial intelligence (AI) companies, thereby and hence making it quite straightforward to design, train, and integrate deep-learning based systems. Moreover, the amount of data available every day is not only enormous, but, growing at an exponential rate over the past few years, there has been an increasing interest in using machine-learning methods to analyze and visualize massive data generated from very different sources and with many different features: social networks, surveillance systems, smart cities, medical diagnosis, business, cyberphysical systems, or media digital data. This special session is designed to serve researchers and developers to publish original, innovative, and state-of-the art machine-learning algorithms and architectures to analyze and visualize large amounts of data.

Finally, biomedical applications are essential in IWINAC meetings. For instance, brain–computer interfaces (BCI) 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), makes a decision (cognition) and, eventually, transmits data back to the source (by means of a BCI), thus closing the communication loop. 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 these tasks. These areas are clear examples of innovative applications in biology or medicine.

The 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 prevails at 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 was one of the main motivations for the organization of IWINAC 2017. The IWINAC 2017 proceedings contain the works selected by the Scientific Committee from nearly 200 submissions, after the review process. The first volume, entitled *Natural and Artificial Computation for Biomedicine and Neuroscience*, 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 *Biomedical Applications Based on Natural and Artificial Computing*, contains the papers related to bioinspired programming strategies and all the contributions related to computational solutions to engineering problems in different application domains.

An event of the nature of IWINAC 2017 could not be organized without the collaboration of a group of institutions and people whom we would like to thank, starting with UNED and Universidad Politécnica de Cartagena. The collaboration of the Universidade da Coruña was crucial, as was the efficient work of the local Organizing Committee, chair by Richard Duro with the close collaboration of José Santos and their colleagues José Antonio Becerra Permuy, Francisco Bellas Bouza, Abraham Prieto, Fernando López Peña, Álvaro Deibe Díaz, and Blanca Priego. In addition to our universities, we received financial support from the Spanish CYTED, Red Nacional en Computación Natural y Artificial, Programa de Grupos de Excelencia de la Fundación Séneca and from Apliquem Microones 21 s.l.

We want to express our gratitude to our invited speakers Prof. Hojjat Adeli (Ohio State University, USA), Prof. Manuel Graña (Universidad del País Vasco, Spain), Prof. Martin Greschner (Carl von Ossietzky Universit of Oldenburg, Germany), and Prof. Gusz Eiben (Vrije Universiteit Amsterdam, The Netherlands) for accepting our invitation and for their magnificent plenary talks.

We would also like to thank the authors for their interest in our call for papers and their 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 pre-organized sessions and workshops on autonomous and relevant topics under the IWINAC global scope.

Our sincere gratitude also goes to Springer and especially to Alfred Hofmann and his team, Anna Kramer, Elke Werner, and Christine Reiss, 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 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 would like to dedicate these two volumes of the IWINAC proceedings to Professor Mira. In 2018, it will have been 10 years without him, without his inquiring spirit. We miss him greatly.

June 2017

José Manuel Ferrández Vicente
José Ramón Álvarez-Sánchez
Félix de la Paz López
Javier Toledo Moreo
Hojjat Adeli

http://www.springer.com/978-3-319-59739-3

Natural and Artificial Computation for Biomedicine and Neuroscience
International Work-Conference on the Interplay Between Natural and Artificial Computation, IWINAC 2017, Corunna, Spain, June 19-23, 2017, Proceedings, Part I

Ferrández, J.M.; Álvarez-Sánchez, J.R.; de la Paz, F.; Toledo Moreo, J.; Adeli, H. (Eds.)

2017, XXII, 476 p. 160 illus., Softcover
ISBN: 978-3-319-59739-3