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Biological and Artificial Computation: From Neurosciene to Technology

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Preface

Neural computation is considered here in the dual perspective of *analysis* (as reverse engineering) and *synthesis* (as direct engineering). As a science of *analysis*, neural computation seeks to help neurology, brain theory, and cognitive psychology in the understanding of the functioning of the nervous system by means of computational models of neurons, neural nets, and subcellular processes, with the possibility of using electronics and computers as a "laboratory" in which cognitive processes can be simulated and hypotheses proven without having to act directly upon living beings.

As a *direct* engineering (how can we build sub-symbolic intelligent machines?), neural computation seeks to complement the symbolic perspective of artificial intelligence (AI), using the biologically inspired models of distributed self-programming and self-organizing networks, to solve those non-algorithmic problems of function approximation and pattern classification having to do with changing and only partially known environments. Fault tolerance and dynamic reconfiguration are other basic advantages of neural nets.

In the sea of meetings, congresses, and workshops on ANNs, IWANN'97, the fourth International Work-Conference on Artificial Neural Networks, that took place in Lanzarote, Canary Islands (Spain), 4 - 6 June, 1997, focused on the three subjects that most worry us:

(1) The search for biologically inspired new models of local computation architectures and learning along with the organizational principles behind the complexity of intelligent behavior.

(2) The search for some methodological contributions in the analysis and design of knowledge-based ANNs, instead of "blind nets", and in the reduction of the knowledge level to the sub-symbolic implementation level.

(3) The cooperation with symbolic AI, with the integration of connectionist and symbolic processing in hybrid and multi-strategy approaches for perception, decision, and control tasks, as well as for case-based reasoning, concept formation, and learning.

To contribute to the formulation and partial solution of these global topics, IWANN'97 offered a brain-storming interdisciplinary forum in advanced neural computation for scientists and engineers from biology, neuroanatomy, computational neurophysiology, molecular biology, biophysics, mathematics, computer science, artificial intelligence, parallel computing, electronics, cognitive sciences, and all the concerned applied domains (sensory systems and signal processing, monitoring, diagnosis, classification and decision making, intelligent control and supervision, perceptual robotics and communication systems).

The papers presented here correspond to talks delivered at IWANN'97, organized by the Universidad Nacional de Educación a Distancia (UNED), Madrid, Universidad de Las Palmas de Gran Canaria, and Universidad Politécnica de

Catalunya, in cooperation with the Asociación Española de Redes Neuronales (AERN), IFIP Working Group in Neural Computer Systems, WG10.6, Spanish RIG IEEE Neural Networks Council, and the UK&RI Communication Chapter of IEEE.

Sponsorship has been obtained from the Spanish CICYT and DGICYT (MEC) and the organizing universities (UNED, Las Palmas, and Catalunya).

After the evaluation process, 142 papers were accepted for oral presentation or poster, according to the recommendations of reviewers and the author's preferences. The three extended papers corresponding to the invited speakers (DeFelipe, Eckhorn, and Ienne) have been included as introductions to the corresponding topics of neuroscience, neural modeling in perception, and implementation.

We would like to thank all the authors as well as all the members of the international program committee for their labor in the production and evaluation of the papers. Only by proceeding with this severe averaging of the external experts' reviews, could we be sure to maximize the originality, technical quality, and scientific relevance of this event. We also would like to mention the effort of the authors of rejected papers, mainly because they were immature proposals or topics not covered by IWANN.

Last but not least, the editors would like to thank Springer-Verlag, in particular Alfred Hofmann, for the continuous and excellent cooperative collaboration from the first IWANN in Granada (1991, LNCS 540), the successive meetings in Sitges (1993, LNCS 686) and Torremolinos (1995, LNCS 930), and now in Lanzarote.

The papers published in this volume present the current situation in natural and artificial neural nets, with a significant increase in the contributions related to the biological foundations of neural computation and the computational perspective of neuroscience. We have organized the papers in the following sections:

- *Biological Foundations of Neural Computation*
- *Formal Tools and Computational Models of Neurons and Neural Nets Architectures*
- *Plasticity Phenomena (Maturing, Learning and Memory)*
- *Complex Systems Dynamics*
- *Cognitive Science and IA*
- *Neural Nets Simulation, Emulation and Implementation*
- *Methodology for Data Analysis, Task Selection and Nets Design*
- *Neural Networks for Communications, Control and Robotics*

This book endeavors to summarize the state of the art in neural computation with a focus on biologically inspired models of the natural nervous system. The complexity of the nervous system is now accepted, and a significant part of the scientific community has returned to anatomy and physiology, rejecting the temptation to use models which are clearly insufficient to cope with this complexity. At the same time there is an increasing interest in the use of computational models of neural networks to improve our understanding of the functional organization of the brain. Finally, there is

also evidence of a lack of formal tools enabling the hybridization of the symbolic and connectionistic perspectives of artificial intelligence in the common goal of making computational the knowledge of human experts in technical domains related with perception, communication, and control. All these developments, as reported in these proceeding, are needed in order to bring neuroscience and computation closer together. To recognize the disparity that exists between the richness and fineness of the nervous system and the crudeness we use in handling it is a good step forward.

Madrid, March 1997

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