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Non-conventional computing paradigms

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The conventional computing paradigms are usually two: the symbolic representational one and the connectionist (or mechanistic) approach. The first one is dominant since the Christening of Artificial Intelligence in the Summer of 1956. This paradigm assumes that everything that has to be computed needs previously to be represented in terms of data structures and inferential schemes, including algorithms and implementation programs. So, all the information needs to be explicit from the beginning in a declarative manner.

The second paradigm, usually known as connectionist, includes the field of Artificial Neural Networks, and other biologically inspired approaches. In essence the first paradigm is related to General Purpose von Neumann Architecture, while the second one is related to Special Purpose Machines in which the control is explicit in the specific electronic circuit that embodies each information processing machine.

In addition to these two dominants paradigms, there are other new approaches to the task of computation, not so well established, but in the brainstorming frontier of the science and engineering. These new approaches include Quantum Computation, Membrane Computation, Evolutionary Algorithms and many other Conceptual Proposals still far away from feasible and competitive implementations. This special issue of Natural Computing deals with some of these new paradigms. The articles are extended versions of papers selected from the second International Work Conference on the Interplay between Natural and Artificial Computation (IWINAC) held in La Manga del Mar Menor (Spain) during June 2007.

Dedication: Professor Jose Mira passed away during the elaboration of this special issue. As a pioneer in the field of Cybernetics, he was enthusiastically promoting this interdisciplinary research. All the authors and the Iwinac committee would like to dedicate this special issue of Natural Computing in honour to his memory and his scientific work.

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The Quantum Computing approach integrates two of the main scientific findings of the last century: Information Theory and Quantum Mechanics. Under this umbrella we include two papers of Monserrat and Calixto. The first one is more related to the Quantum Processing in Neuroscience, trying to explain to some extent, consciousness, and the second one applies these basic principles to parallelism, entanglement and cryptography.

The Membrane Paradigm is inspired by mechanisms in the cell and the chemical reactions with different components and compartments and the production laws and communication rules between the compartmental limits. In this aspect, we include the papers of Paun and Mauri. The first one deals with the power and efficiency in spiking neural P systems, while the second one relates to Paun's conjecture in Membrane Systems.

The Genetic Approach faces problems of optimisation with heuristics for bounding the searching space according to strategies inspired by biological evolution. The papers "Simulated Evolution of the Adaptability of the Genetic Code Using Genetic Algorithms" and "Fusion of Neural Gas" are representative for this approach. In both cases the computation is not wired within the physical machine that we accommodate for the calculus, instead the problem is stated and solved between the knowledge level and the symbol level.

Finally, we have included two papers, one of J. Mira, and the other of D. Maravall et al. concerning bioinspired paradigms and advanced computational concepts such as intelligence, rationality, computing maps, and meaning understanding.These four approaches are pointing to the frontiers of computation and are representative of the state of-the-art in the search of nature inspired alternatives or complements to the von Neumann architecture.