Special Issue on Membrane Computing:
Part 1

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The present issue contains a selection of papers resulting from the 9th Brainstorming Week on Membrane Computing, held in Sevilla, January 31 to February 4, 2011, by the Research Group on Natural Computing from the Department of Computer Science and Artificial Intelligence of Sevilla University.

Membrane computing is a branch of Natural Computing aiming to abstract computing models from the structure and functioning of the biological cell and from the organization and cooperation of cells in tissues, neural nets, populations, and so forth. The obtained models, called *P systems*, were vividly investigated, mainly from the computability point of view (power and efficiency), but also as models of biological processes, in relation with computer science and other contexts. This research area was initiated in 1998, with the journal version published in Păun (2000), and research literature on this area continues to grow. In 2003, ISI considered membrane computing as an "emerging research area of computer science", with the initial paper qualified as "fast breaking". Several monographs were published and a comprehensive handbook has recently appeared (Păun, Rozenberg, & Salomaa, 2010). Details can be found at the domain website from http://ppage.psystems.eu.

P systems are distributed and parallel computing devices, processing multisets of objects (symbols or strings) in compartments defined by membranes (intuitively understood as 3D vesicles). Rules evolving objects and compartments are inspired by biochemistry. Many classes of P systems were defined, most equivalent in power to Turing machines and able to solve computationally hard problems in a feasible time (by means of a time-space trade-off, with the exponential space obtained by means of biologically inspired operations, such as membrane division, membrane creation, and string replication). Numerous applications were reported, especially in modeling biological or biomedical processes, ecosystems, and economic processes. Many software simulators are available and attempts toward implementations on a dedicated hardware have been made.

Since 2000, a yearly workshop on membrane computing (WMC) has taken place. In 2010, the series continued in the form of a conference on membrane computing (CMC). Simultaneously, starting in 2003, a yearly meeting devoted to membrane computing was organized, called "Brainstorming Week on Membrane Computing" (BWMC), meant to be a place for interaction between researchers in this area, working together for one week,

exchanging ideas and problems, and looking for new results and new applications.

The first BWMC was organized at the beginning of February 2003 in Rovira i Virgili University, Tarragona, and the next took place in Sevilla in the beginning of February from 2004 through and 2011. These meetings proved to be very fruitful, with many papers emerging from the interaction. Each year a volume with the related papers was published as a research report and a selection from these papers was published as a special issue (sometimes two) of an international journal. These journal volumes are: *Natural Computing* (volume 2, number 3, 2003), *New Generation Computing* (volume 22, number 4, 2004), *Journal of Universal Computer Science* (volume 10, number 5, 2004), *Soft Computing* (volume 9, number 9, 2005), *International Journal of Foundations of Computer Science* (volume 17, number 1, 2006), *Theoretical Computer Science* (volume 372, numbers 2-3, 2007), *Fundamenta Informaticae* (volume 87, number 1, 2008), *International Journal of Unconventional Computing* (volume 5, number 5, 2009), *International Journal of Computers, Control and Communication* (volume 4, number 3, 2009), and *Romanian Journal of Science and Technology of Information* (volume 13, number 2, 2010).

The papers included in this two part special issue of the *International Journal of Natural Computing Research* were selected to provide a balanced view on this research area. The topics covered range from basic theoretic issues (such as the study of synchronization in P systems and the power of P colonies – systems with very simple components), investigations on recently introduced ideas (such as spiking neural P systems), computational complexity issues, to implementations on dedicated hardware, and applications (both in biomedicine and computer graphics, logics, and algorithmics). In the spirit of the brainstorming, beyond providing results, most of the papers also raise interesting research problems.

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Pierluigi Frisco is a lecturer in the School of Mathematical and Computer Science, Heriot-Watt University, UK. After completing his PhD at Leiden University, The Netherlands (2004), Dr. Frisco was appointed lecturer in the Department of Computer Science at the University of Exeter from where he moved to his present post in 2006. Dr. Frisco's research has always been at the interface of Computer Science, Mathematics and Biology. He has contributed to DNA computing, Membrane Computing and Systems Biology studying several aspects of computational and descriptional complexity, solving open problems and introducing conformon-P systems: a new modelling platform for biological processes. Lately Dr. Frisco's research interests broadened into linking the underlying topology of biological process to their dynamics. Dr. Frisco is member of the Conference on Membrane Computing steering committee, he is review editor of the International Journal of Natural Computing Research *and editor of Scholarpedia for the entry Molecular Computing. The research funding obtained so far by Dr. Frisco includes grants from The Royal Society, The Nuffield foundation and EPSRC. He has also received the Diploma of Excellence in Membrane Computing in recognition of his monograph Computing with Cells, Advances in Membrane Computing (Oxford University Press).*

Gheorghe Păun graduated the Faculty of Mathematics, University of Bucharest, in 1974 and received his PhD in mathematics (with specialization in computer science) from the same university in 1977. He held a research position at the University of Bucharest, and from 1990 he is at the Institute of Mathematics of the Romanian Academy, where he is currently a senior researcher. His main research areas are formal language theory and its applications, computational linguistics, DNA computing, and membrane computing; this last research area was initiated by him, in 1998, and the respective models are now called P systems, see http://ppage. psystems.eu). He has published a large number of research papers (collaborating with many researchers worldwide), has lectured at over 100 universities, and gave numerous invited talks at recognized international conferences. He has published eleven monographs in mathematics and computer science (some of them translated in Japanese, Chinese, Russian), has (co)edited over seventy collective volumes and special issues of journals, and also published many popular science books, books on recreational mathematics (games), and fiction books (he is a member of the Romanian Writers Association).

Mario J. Pérez-Jiménez received his degree in mathematics from the Barcelona University and the doctor degree in mathematics from the Sevilla University. In the past, he was associated professor at the University of Barcelona. Currently, he is full professor of Computer Science and Artificial Intelligence at the University of Sevilla, where is the head of the Research Group on Natural Computing. His main research fields are computational complexity theory, natural computing, membrane computing, bioinformatics, and computational modeling for systems biology and population biology. He has published twelve books in computer science and mathematics, and over 200 scientific papers in international journals (collaborating with many researchers worldwide). He is the main researcher in various European, Spanish and Andalusia research grants. He has been an independent expert to the evaluation of NEST (New and Emergent Science and Technology) proposals under the Sixth Framework Programme of the European Community, and from May 2006 he is an European Science Foundation peer reviewer.

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