Foreword

The present volume contains a selection of papers that emerged from the Tenth Brainstorming Week on Membrane Computing (BWMC), held in Sevilla, from January 30 to 3 February 2012, in the organization of the Research Group on Natural Computing from the Department of Computer Science and Artificial Intelligence of Sevilla University. This is a series of yearly meetings that started in 2003, in Rovira i Virgili University, Tarragona, with all the next editions taking place in Sevilla at the beginning of February, each year.

Membrane computing is a branch of natural computing, whose aim is to abstract comput-ing models (data structures, operations about them, ways to control the computation, computing architectures) from the organization and the functioning of the living cell and from populations of cells. The area was initiated in the fall of 1998, and it is already well developed, both at the the-oretical level and in what concerns the applications. The proposed models are called *P systems*, and the basic one consists of a cell-like (hierarchical) arrangement of membranes, delimiting compartments where multisets of objects evolve according to rules associated with the compart-ments. (Thus, in its basic form, membrane computing is devoted to distributed parallel multiset processing.) Many classes of P systems were introduced, with biological motivation (tissue-like, neural-like, passing objects through membrane by symport and antiport operations, and so on), mathematical motivation (e.g. instead of multisets of symbol objects, to use other data structures, such as sets or multisets of strings), computer science motivation (synchronous or asynchronous systems, deterministic or nondeterministic, able or not to produce an exponential working space in linear time, etc.); in turn, the applications (especially those in biology, biomedicine, ecology) needed versions of P systems where the evolution is controlled by probabilities, reaction rates, or similar numerical coefficient associated with the rules. Besides the various applications (in bio-modelling, computer graphics, approximate optimization, robot control), two main classes of (theoretical) results were obtained: (a) *universality results* (many classes of P systems, with a rather restricted structure, are equivalent in power to Turing machines) and (b) *efficiency results* (when a space–time trade-off is possible, e.g. by providing rules for dividing membranes, then polynomial solutions can be obtained to computationally hard problems, typically, **NP**-complete problems, but also characterizations of many other complexity classes were found, including **PSPACE**).

Updated information about membrane computing can be found at the domain website, at http://psystems.ppage.eu, including information about the two yearly dedicated meetings, the Conference on Membrane Computing (CMC) and the BWMC.

In the style of previous meetings in this series, the tenth BWMC was conceived as a period of active interaction among the participants, with the emphasis on exchanging ideas and cooperation. Several ‘provocative’ talks were delivered, mainly devoted to open problems, research topics, and conjectures waiting for proofs, followed by intense cooperation among the 40 participants. The

efficiency of this type of meetings was again proved to be very high and the proceeding volumes published as a research report of Sevilla University (see the website of the Research Group on Natural Computing from Sevilla University, http://www.gcn.us.es) are an illustration of this efficiency. These proceedings are a working instrument, part of the interaction started during the stay of authors in Sevilla, meant to make possible a further cooperation, this time having a written support.

Ten papers were selected for the present volume. They have been further elaborated, enlarged and polished before being submitted, then they passed the usual reviewing process of the journal (each paper received two or three referee reports).

The selection was made in such a way to have a balanced distribution of topics, aiming to provide a balanced glimpse to membrane computing. Some papers deal with 'classic' theoretical issues, such as the power of symport–antiport systems [2] or the efficiency of cell division in solving hard problems [8], others deal with intricate ways of organizing the computation, such as the role of the clock [5] and the control of evolution by means of energy quanta associated with the rules [1]. Two papers propose new formalizations of P systems [3] or prove the usefulness of such new formalizations, specifically, of the recently introduced kernel P systems [4]. One paper is devoted to spiking neural P systems, a class of computer devices inspired from the brain organization and the way neurons cooperate by means of spikes [6]. The remaining three papers are of a more applicative nature. They deal with a version of P systems, called MP systems, which proved to be rather useful in modelling biological processes [7], with fuzzy P systems, a framework where important issues, such as adaptation and learning, can be considered [10] and, finally, with using the so-called numerical P systems in devising robot controllers [9]. It should be noted the variety of subjects and the fact that all of them can be considered as placed at the intersection of mathematics, computer science, and 'real life'.

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