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Membrane Computing [and Graph Transformation]

Gheorghe Păun

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Institute of Mathematics of the Romanian Academy, Bucharest, Romania, and
Research Group on Natural Computing, Sevilla University, Spain
george.paun@imar.ro, gpaun@us.es

Abstract: Introduction to membrane computing, with an eye on graph theory issues.

Keywords: Natural computing, membrane computing, P system, Turing computability

Membrane computing is a branch of natural computing initiated in [5] which abstracts computing models from the organization and the functioning of the living cell and from the cooperation of cells in tissues, organs (brain included) or other higher order structures. The resulting models, called P systems, can be briefly described as devices which process multisets of abstract objects in the compartments delimited by membranes. According to the arrangement of membranes, there are cell-like P systems (with the membranes embedded hierarchically), tissue-like (with the membranes placed in the nodes of an arbitrary graph), and neural-like P systems (with a special case, of spiking neural P systems).

A P system can be used as a computing device, generating/accepting sets of numbers, of vectors of numbers, languages, sets of trees or graphs, arrays, etc. Many variants were considered, with biological, mathematical, or computer science motivation, and most of them were proved to be Turing complete. When an enhanced parallelism is available, e.g., by means of membrane division, computationally hard problems (typically, NP-complete problems) were solved in polynomial time – by a space-time trade-off.

Recently, membrane computing was much used as a framework for devising models in biology, economics, linguistics, computer science, optimization.

The talk is intended to be a general introduction to membrane computing, starting by placing it in natural computing, presenting the basic ideas and main types of results and applications, and pointing whenever necessary the interplay with graph theory and graph transformation (graph theory provides ideas/tools for studying P systems, while P systems can be used for handling graphs, e.g., as objects in membranes, or indirectly, as graphs describing membrane structures). Research topics are mentioned. No biological background is necessary.

For further (introductory) details in membrane computing, the reader is referred to the monograph [6], the volume [1], the papers [7], [3], as well as to the web page [10] (a complete bibliography of the domain can be found at this site, many downloadable papers, software, applications, etc.).

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