Membrane Computing – After 7 Years

Initiated by Gheorghe Păun
Corresponding Member of the Romanian Academy (since October 1997)

Seminal paper: Gh. Păun, Computing with membranes,
J. Computer and System Sciences, 61, 1 (2000), 108–143
circulated on web from November 1998,
as TUCS Report 208 (`www.tucs.fi`)

From the very beginning, the community has called the respective computing devices "P systems", so that in this moment there are over 500 papers with the first letter of "Păun" in the title.

The initial goal was to abstract a computing model from the structure and the functioning of the living cell.

In the meantime, the domain has known a broad development, and there are now investigated cell-like, tissue-like, neural-like P systems. Furthermore, besides the vivid theoretical investigation, membrane computing is more and more used as a framework for devising models, especially for cell biology/medicine, and for populations of cells/bacteria, but also for economics, computer science, linguistics.

Monograph: Gh. Păun, *Membrane Computing. An Introduction*,
Springer-Verlag, Berlin, 2002
Volume with applications: G. Ciobanu, Gh. Păun, M.J. Pérez-Jiménez, eds.,
Applications of Membrane Computing,
Springer-Verlag, Berlin, 2005

Since 2001, there is a web page of membrane computing, organized under the auspices of EMCC (European Molecular Computing Consortium), and maintained at the University of Milano, Italy: `http://psystems.disco.unimib.it`

The bibliography from this website contained at October 20, 2005, three books, 22 collective volumes and 13 PhD theses, with a total of almost 700 titles. More than 15 other PhD theses are under elaboration in various countries.

Starting from 2000, one organizes an yearly *Workshop on Membrane Computing* (Curtea de Argeş, Romania – 2000, 2001, 2002; Tarragona, Spain – 2003; Milano, Italy – 2004; Viena, Austria – 2005; for 2006 the workshop is planned in Leiden, The Netherlands), with volumes published in the *Lecture Notes in Computer Science* series of Springer-Verlag (the papers presented at the second edition of the workshop were published in a special issue of the journal *Fundamenta Informaticae*).

From 2003 one also organizes every year a *Brainstorming Week on Membrane Computing* (Tarragona – 2003; Sevilla, Spania – 2004, 2005; the next brainstorming will be

also organized in Sevilla).

From 2005 started to be organized also an *Workshop on Theory and Applications of P Systems*, mainly devoted to applications (Timişoara, Romania – 2005; Wuhan, China – 2006).

In 2004 it took place in Palma de Mallorca a specialized workshop, dedicated to uncertainty (probabilistic, fuzzy sets, rough sets approaches) in membrane computing. In July 2006, a satellite workshop of ICALP will be devoted to the bridge between membrane computing and brane calculi (with Gh. Păun and L. Cardelli as invited speakers).

The fast development of the field (not very frequent in the history of computer science) made Thomson Institute for Scientific Information, ISI, to name in February 2003 the initial paper of Gh. Păun as "fast breaking paper" (see `http://esi-topics.com/fbp/fbp-february2003.html`). In 2004, in the list of most cited papers in computer science compiled by ISI, this paper was placed on position 154, from a total of 1567 papers taken into consideration.

In October 2003, one more paper of Gh. Păun, written in collaboration with his son, A. Păun (professor at Lousiana Tech, Ruston, USA), was mentioned by the same ISI as "the citation leader in the category of Emergent Research Front in Computer Science: Membrane Computing" (see `http://esi-topics.com/erf/october2003.html`).

Each time, an interview of Gh. Păun, together with a photo, was posted on the web page of ISI.

In 2005, ISI has sent to Gh. Păun three post cards with the following contents:

> Congratulations, G. Paun Since 2000, you have been cited ... times for your article... This means that the number of citations your article received places it in the top 1% within its field according to "Essential Science Indicators". Your work is highly influential, and is making a significant impact among your colleagues in your field of study.
>
> Congratulations on your extraordinary career accomplishment!

In October 2005, in the ISI web page, at "Essential Science Indicators" (`http://portal02.isiknowledge.com/portal.cgi/portal.cgi?DestApp=ESI&Func=Frame&Init=Yes&SID=A3AHekl2M94bMHmghhG`) there are four papers by Gh. Păun mentioned at the section "Highly cited papers (last 10 years)", all of them about membrane computing, having 189, 37, 33, 13 citations, respectively. (The first three are the papers for which ISI has sent post cards with congratulations.)

In fact, in "Scientist rankings in computer science", Gh. Păun appears on position 82 (out of 1826 computer scientists from all around the world considered by ISI on the basis of their citations from the last 10 years).

Special issues of international journals devoted to P systems (besides the four volumes from *Lecture Notes in Computer Science* related to the Workshops on Membrane Computing):

1. *Romanian Journal of Information Science and Technology*, vol. 5 nr. 2-3 (2002).
2. *Fundamenta Informaticae* (IOS), vol. 49, nr. 1-3 (2002).

3. *Natural Computing* (Kluwer), vol. 2, nr. 3 (2003).
4. *Journal of Universal Computer Science* (Springer), vol. 10, nr. 5 (2004).
5. *New Generation Computing* (Springer-Japan), vol. 22, nr. 4 (2004).
6. *Soft Computing* (Springer), vol. 9, nr. 9 (2005).
7. *International Journal of Foundation of Computer Science* (World Scientific), 2006 (in press)

Other information:

- There are over 250 authors of papers in membrane computing.
- There were/are research projects directly related to membrane computing in USA, UK, Spain, Italy, The Netherlands, etc.
- A Google search for "membrane computing" returns 20,000 – 30,000 entries.
- There are several conferences and journals which have explicitly membrane computing in their scope.
- The appeal of membrane computing comes from the biological inspiration, the generality and versatility of the models, the novelty (multiset processing, in a distributed, cell-like parallel framework), the flexibility of the formalism, the computing power (Turing completeness), the computational efficiency (the massive parallelism makes possible – theoretical – polynomial time solutions for NP-complete problems, based on a space-time trade-off), the possibility of using P systems for modelling biological processes at the level of the cell or of populations of cells (computational systems biology is a fast developing area, which looks for new tools and techniques). From this point of view, of modelling biological processes, P systems have a series of advantages: intrinsic modularity, easy understandability, extensibility and programmability, the capability of handling/observing small populations of molecules.