P systems

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November 25, 2015

Introduction

A P system is a computational model in the field of computer science that performs calculations using a biologically-inspired process. They are based upon the structure of biological cells, abstracting from the way in which chemicals interact and cross cell membranes.

It was introduced in a 1998 report by Gheorghe Păun.
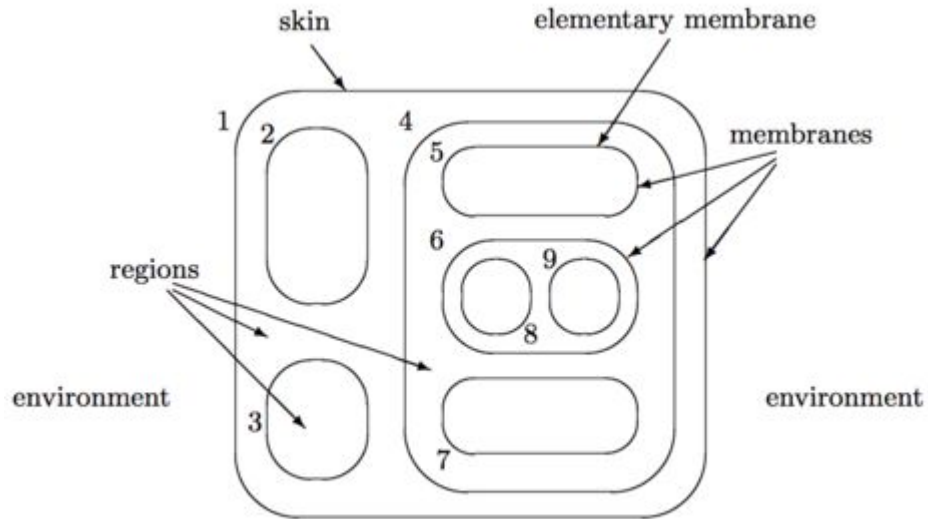
Introduction

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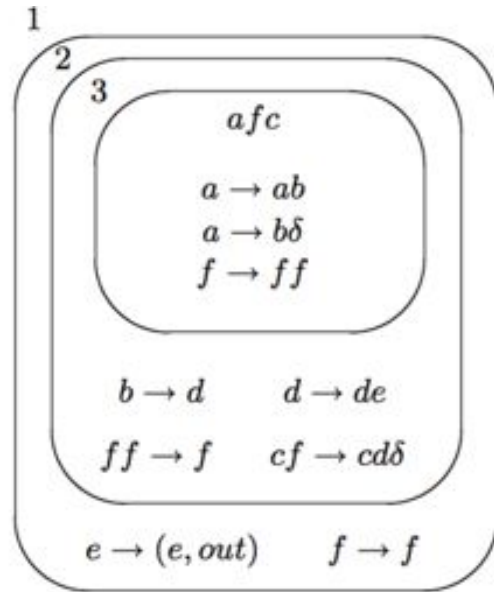
http://www.imar.ro/~gpaun/

Components of a P system

1. The environment

2. Membranes

3. Symbols

4. Catalysts

5. Rules

Fig. 1. A membrane structure.

Components of a P system

The initial configuration of a P system, rules included.

Computation process

1. Assign symbols from a membrane's content to the rule's inputs

2. If all inputs are satisfied, remove all assigned symbols from membrane

3. Create output symbols and hold until all rule assignment, for all membranes, has taken place.

4. Add output symbols to targeted membranes.

5. Dissolve membranes as necessary
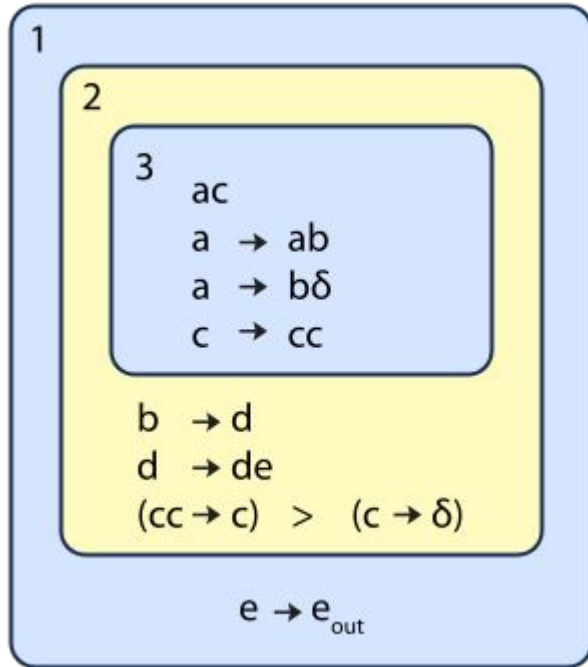
Computation process

Non-deterministic application

The order of rule application is chosen at random.

Maximally parallel application

the rule a ➡ aa has the effect of doubling the number of "a" symbols in its containing membrane each step

Example

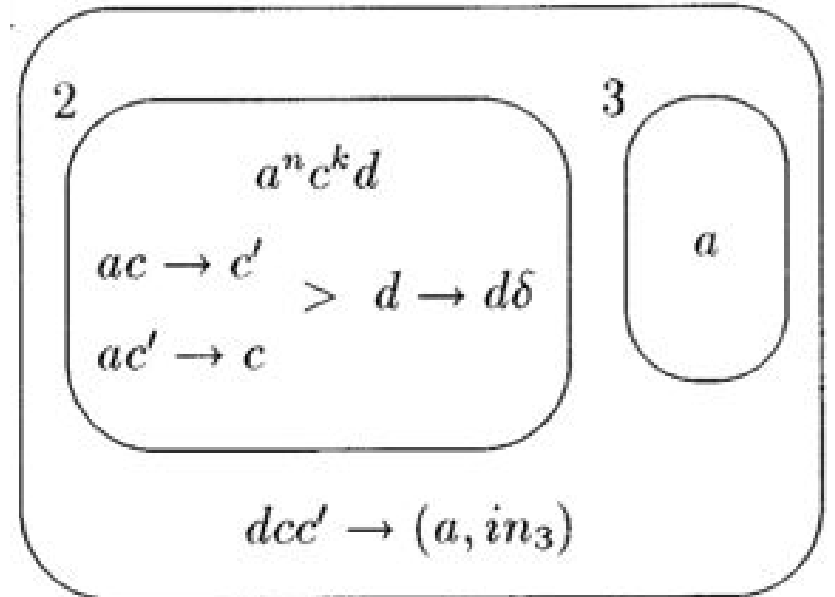The graphical representation of a P system which outputs square numbers

Example

A P system deciding whether k divides n.

The P system membrane structure contains:

Membrane 2:
$$a^n c^k d$$

$$ac \rightarrow c'$$
$$ac' \rightarrow c$$
$$> \quad d \rightarrow d\delta$$

Membrane 3:
$$a$$

$$dcc' \rightarrow (a, in_3)$$

Three main types of P systems

(i) cell-like P systems,

(ii) tissue-like P systems,

(iii) neural-like P systems.

Power and Efficiency

From a theoretical point of view, P systems are both:

powerful as most classes of P systems are Turing complete,

efficient, as many classes of P systems, especially those with enhanced parallelism, can solve computationally hard problems - typically NP-complete problems, but also harder problems.

Applications

Modeling framework, details can be found in [5]

    the general protocol is the following:

    a P system is written which models a given process

    then a program is written to simulate this P system

    after that, computer simulations are performed

There are also applications of other types, e.g., in computer graphics, cryptography, approximate optimization, and so on.

References

[1] https://en.wikipedia.org/wiki/P_system

[2] http://www.scholarpedia.org/article/Membrane_Computing

[3] Păun, Gh. (2000). Computing with membranes. Journal of Computer and System Sciences 61(1): 108-143. Turku Center for Computer Science-TUCS Report 208, November 1998

[4] Păun, Gheorghe (2006). "Introduction to Membrane Computing". Applications of Membrane Computing. Springer Berlin Heidelberg. pp. 1–42.

[5] Ciobanu, G.; Păun, Gh. and Perez-Jimenez, M.J. (2006). Applications of Membrane Computing. Springer-Verlag, Heidelberg.