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REACTIONS IN MEMBRANE SYSTEMS

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BEFEKTETÉS A JÖVŐBE

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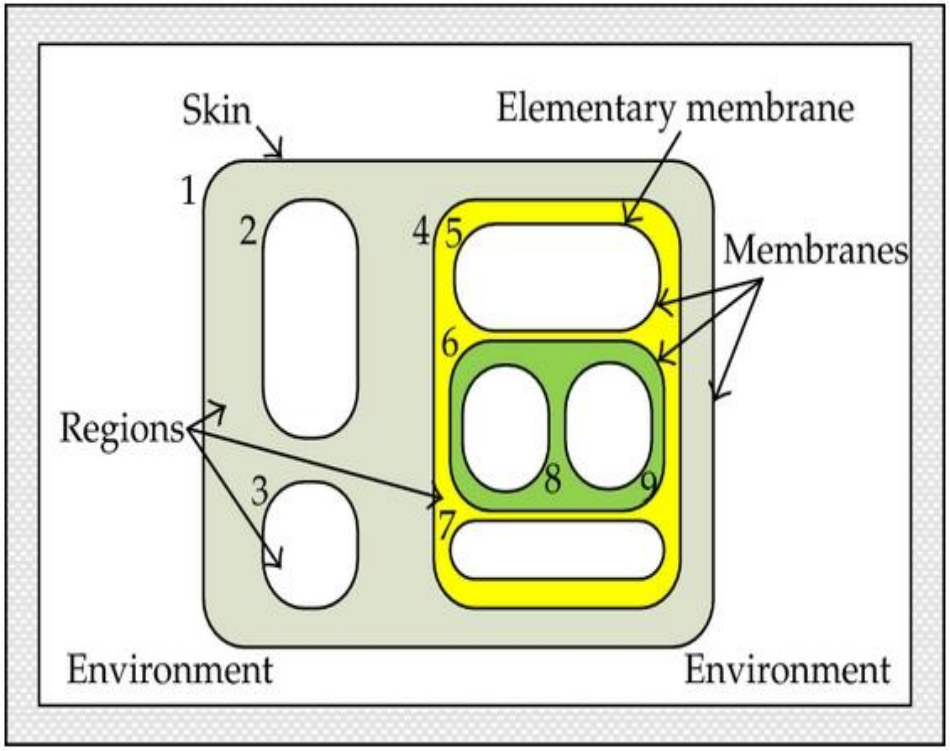
MEMBRANE COMPUTING



The paradigmatic idea of membrane computing is to see whether we can construct computing devices that mimic living cells: structure and functioning.

-- Gheorghe Păun, 1988

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Membrane systems (P systems) are arranged in a hierarchical structure and processing multisets of symbol-objects.

Such a construct is a tuple

$$\Pi = (O, \mu, w_1, \dots, w_n, R_1, \dots, R_n, i_0), \text{where}$$

- O is an alphabet and its elements are called objects,
- μ is a membrane structure consisting of m membranes, labeled with $1, \dots, n$; n is called the degree of Π,
- $w_1, \dots, w_n$ are multisets of objects associated with the n cells of μ,
- $R_i, 1 \leq i \leq n$, are finite sets of evolution and communication rules over O;
- R_i is associated with the cell i of μ. The rules are of the form $u \to v$, where u and v are multisets with $u \in O^*$ and $v \in (O \times \{1,2, \dots, n\})^*$. This means object in v are sent to other cells in μ.
- $i_0 \in \{1, \dots, n\}$ is called output cell of Π.

REACTION SYSTEMS

➢**Reaction systems** were introduced about 10 years ago, then the topic matured into a fruitful and dynamically evolving research area which attracted a noticeable group of researchers.

➢The original motivation was the understanding of interactions of **biochemical reactions** in the living cell and since then reaction systems have developed as an innovative approach to formal modelling of **biological systems**.

➢They have also become a popular novel model of **interactive computation**.

REACTIONS

A reaction is a 3-tuple $a = (R, I, P)$ of finite non-empty sets. If S is a set such that $R, I, P \subseteq S$ then we say that a is a reaction in S.

The set R, also denoted by R_a, is the reactant set of a, the set I, also denoted by I_a, is the inhibitor set of a, and the set P, also denoted by P_a, is the product set of a.

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By $rac(S)$ we denote the set of reactions in S. For a set A of reactions, we have

- $R_A = \bigcup_{a \epsilon A} R_a$
- $I_A = \bigcup_{a \epsilon A} I_a$
- $P_A = \bigcup_{a \epsilon A} P_a$

Note:-

The reaction (∅,∅,∅) is called the empty reaction and denoted by Φ.

REACTION SYSTEMS

A reaction system, abbreviated rs, is an ordered pair $\boldsymbol{A} = (S, A)$ such that S is a finite set, and $A \subseteq rac(S)$. The set S is called the background (set) of $\boldsymbol{A}$.

For a reaction system $\boldsymbol{A} = (S, A)$ and a set $T \subseteq S$, the result of $\boldsymbol{A}$ on T, denoted $res_{\boldsymbol{A}}(T)$, is defined by $res_{\boldsymbol{A}}(T) = \cup_{a \in A} res_a(T)$.

A reaction a is enabled on T if $R_a \subseteq T,\ I_a \cap T = \emptyset$. The result of a on T is P_a if a is enabled on T, otherwise it is the emptyset.

REACTION SYSTEMS, P SYSTEMS

Differences between Reaction systems and P systems:

- Reaction systems work with sets and P systems with multisets;
- Non-permanency: in case of Reaction systems if an object does not take part in any of the reactions performed simultaneously, then it disappears.

P SYSTEMS WITH REACTIONS

A P system with reactions is a construct,

$$\Pi_{rs} = (S, \mu, W_1, \ldots, W_n, A_1, \ldots, A\_n, i_0)$$

where

S is the background set,

μ is a membrane structure consisting of m membranes, labeled with $1, \ldots, n; n$ is called the degree of Π,

$W_1 \ldots W_n \in S$ are sets associated with the n cells of μ, called initial sets,

$A_i, 1 \leq i \leq n$, are finite sets of reactions associated with the n cells of μ,

and $i_0 \in \{1, \ldots, n\}$ is called output cell of Π_{rs}.

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How these systems function?

The main idea is to associate the evolution rules of P systems with reactions of Reaction systems.

Communication rules can be simulated by the inhibitor set.

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For example:

A P system with reactions can work as follows:

- In each membrane i there is a set of reactants T_i
- Reaction set A_i is applied to T_i
- The new set will be P_i,
- Objects that belong to I_i are communicated to the neighbouring membranes

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Problems:

What can we say about the dynamics of these systems?

What about the motion of (different) objects between the membranes?

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THANK YOU

FOR YOUR ATTENTION!