Inhibiting the parallelism of P systems

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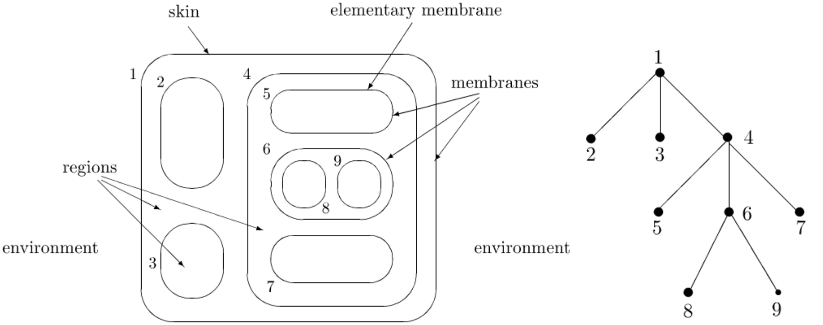
1. Overview of P systems
    - P systems
    - Variants
2. Sequential P systems with inhibitors
    - Accepting case
    - Generating case

Membrane structure



Contents of the membrane

- multiset of objects
  - $a \mid b \mid b$
- rewriting rules
  - $a \mid b \mid b \to a \mid a_{out} \mid b_{in_6}$
  - $b \to a \mid \delta$

P system

We define a P system as
$\Pi = (V, \mu, w_1, w_2, \ldots, w_m, R_1, R_2, \ldots, R_m)$, where:

- V is an alphabet of objects
- μ is a membrane structure
- $w_1, w_2, \ldots w_m$ are initial multisets of objects in membranes $1 \ldots m$, $w_i \subseteq \mathbb{N}^V$
- $R_1, R_2, \ldots, R_m$ are sets of rewriting rules in membranes $1 \ldots m$, where

$$R_i \subseteq (\mathbb{N}^V \setminus 0^V) \times \mathbb{N}^{V \times (\{here, out\} \cup \{in_1, \ldots in_m\})}$$

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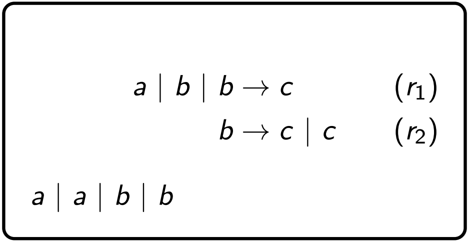

$$a \mid b \mid b \rightarrow c \qquad (r_1)$$

$$b \rightarrow c \mid c \qquad (r_2)$$

$$a \mid a \mid b \mid b$$

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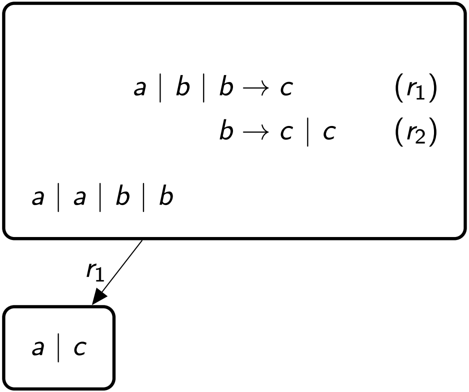

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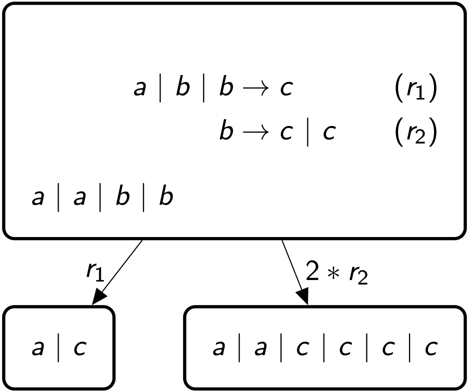

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r_1

$2 * r_2$

$a \mid c$

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- Parikh mapping: PsRE

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- asynchronous ($\sim$ sequential in most cases) [Freund, 2005]
- minimal parallelism (PsRE) [Ciobanu et al., 2007]

Extensions of sequential P systems

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- **inhibitors [Kováč, 2014, submitted]**
- further study (rules with emptyness detection, . . .)

Register machine

Minsky register machine is $M = (n, P, i, h)$, where:

- n is the number of registers
- P is a set of labeled instructions of type:
  - $(add(r), k, l)$
  - $(sub(r), k, l)$
  - $halt$
- i is the initial instruction
- h is the final instruction

Simulation of register machine

- Contents of register j is represented by the multiplicity of the object a_j
- For an instruction $(add(r), k, l)$ there is a rule $e \to a_j|f$
- For an instruction $(sub(r), k, l)$ there are rules
  - $e|a_j \to f$
  - $e \to z|\not{a}_j$
- Halting rules
  - $h|a_j \to h|\#$ for all $a \leq j \leq n$
  - $\# \to \#$

Overview of the simulation for the generating case

- Simulation of a maximal parallel step
- Phases of membranes: *RUN* and *SYNCHRONIZE*, represented by objects

Major difficulties

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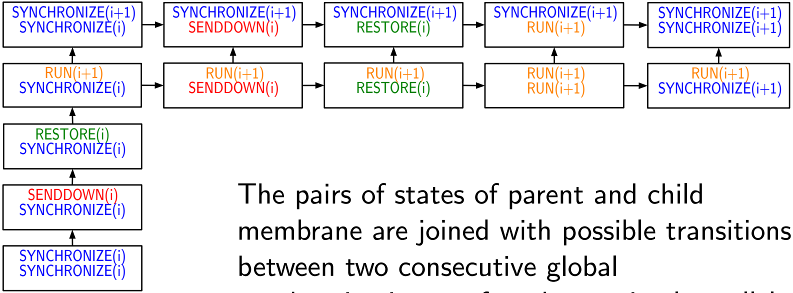
    - add *RESTORE* phase
- Sending objects via membranes
    - add *SENDDOWN* phase

Parent and child membrane phases



SYNCHRONIZE(i+1)
SYNCHRONIZE(i)

SYNCHRONIZE(i+1)
SENDDOWN(i)

SYNCHRONIZE(i+1)
RESTORE(i)

SYNCHRONIZE(i+1)
RUN(i+1)

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RUN(i+1)
SYNCHRONIZE(i+1)

RESTORE(i)
SYNCHRONIZE(i)

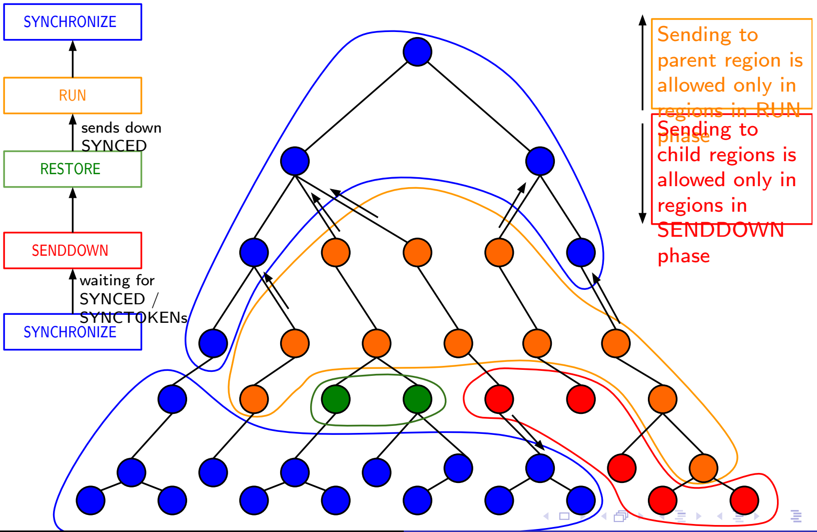
SENDDOWN(i)
SYNCHRONIZE(i)

SYNCHRONIZE(i)
SYNCHRONIZE(i)

The pairs of states of parent and child membrane are joined with possible transitions between two consecutive global synchronizations - after the maximal parallel steps i and i+1

Obr. : Possible pairs of states of parent and child membrane

Snapshot of all membrane states



Sending to parent region is allowed only in regions in RUN phase

Sending to child regions is allowed only in regions in SENDDOWN phase

Thanks for your attention