A toolbox for simpler active membrane algorithms

Alberto Leporati Luca Manzoni Giancarlo Mauri
Antonio E. Porreca Claudio Zandron

Dipartimento di Informatica, Sistemistica e Comunicazione
Università degli Studi di Milano-Bicocca

15th Brainstorming Week on Membrane Computing
31 January–3 February 2017, Sevilla, Spain

Purpose of this work

- Understand which features of recogniser P systems with active membranes are actually essential to characterise their behaviour
- Provide an array of useful extensions which can be added to P systems with active membranes but can be simulated by the original model without loss of efficiency
  - . . . hopefully simplifying active membrane algorithms

Definition

A P system with active membranes with weak non-elementary division rules has the kinds of rule

- $[a \to w]_h^\alpha$
- $a\ [\ ]_h^\alpha \to [b]_h^\beta$
- $[a]_h^\alpha \to [\ ]_h^\beta\ b$
- $[a]_h^\alpha \to b$
- $[a]_h^\alpha \to [b]_h^\beta\ [c]_h^\gamma$
- $[a]_h^\alpha \to [b]_h^\beta\ [c]_h^\gamma$ (nonelementary)

Definition

A P system with rule priorities has any partial order over the set of rules

Definition

A P system with generalised charges has any set of charges $\Psi \supseteq \{+, 0, -\}$

Definition

A generalised recogniser P system Π is a P system employing two distinguished objects yes and no and behaving in any of the three following ways:

1. It sends out an instance of object yes from its outermost membrane before sending out any instance of object no; it can later send out any combination of objects yes and no, and is not required to halt.
2. It sends out an instance of object no from its outermost membrane before sending out any instance of object yes; it can later send out any combination of objects yes and no, and is not required to halt.
3. It halts without sending out neither an instance of yes, nor an instance of no.

The P system Π is said to accept in case 1, and to reject in case 2. The behaviour of 3 can be interpreted as either accepting or rejecting, according to a specified convention.

Lemma

Let Π be a confluent (resp., non-confluent) generalised recogniser P system with priority and generalised charges working in time t. Then, there exists a standard confluent (resp., non-confluent) recogniser P system with priority and generalised charges having the same result and working in time $O(t + d)$, where d is the depth of both P systems. □

Theorem

Let Π *be a generalised confluent recogniser P system using priority and generalised charges working in time* t*. Then, there exists a standard confluent recogniser P system* Π' *without priority and using only two charges having the same result as* Π *and working in time* $O(r \times (d + t))$*, where* r *is the number of rules of* Π *and* d *its depth. Furthermore, the mapping* $\Pi \mapsto \Pi'$ *can be computed in polynomial time with respect to the length of the description of* Π*.* □