# Sequential P Systems with Active Membranes Working on Sets

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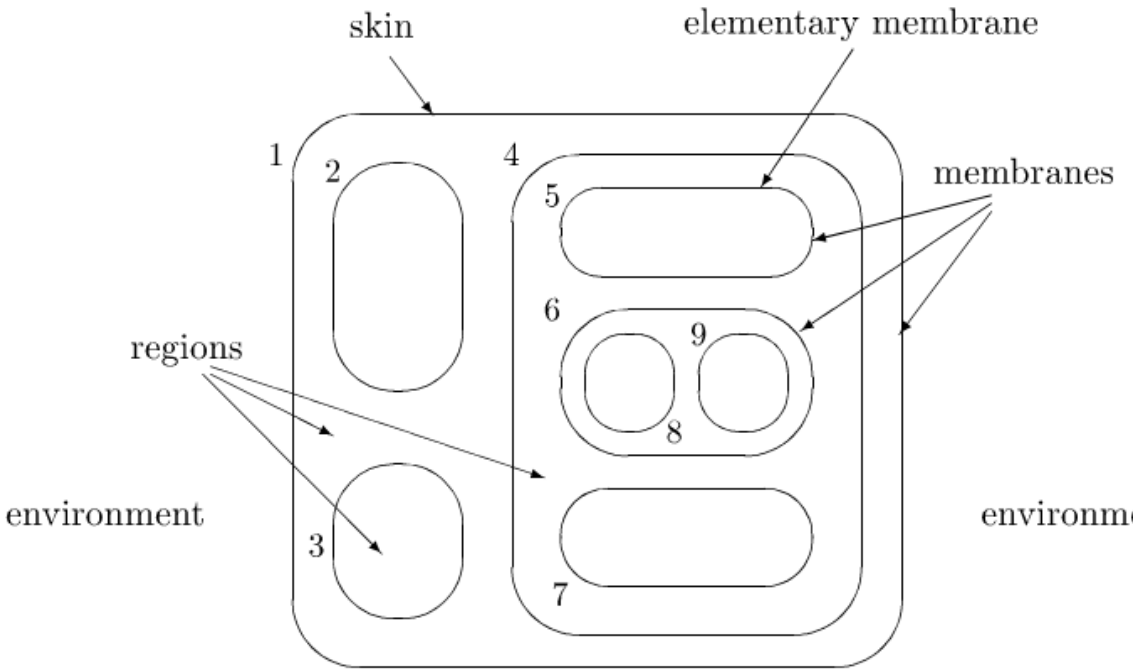
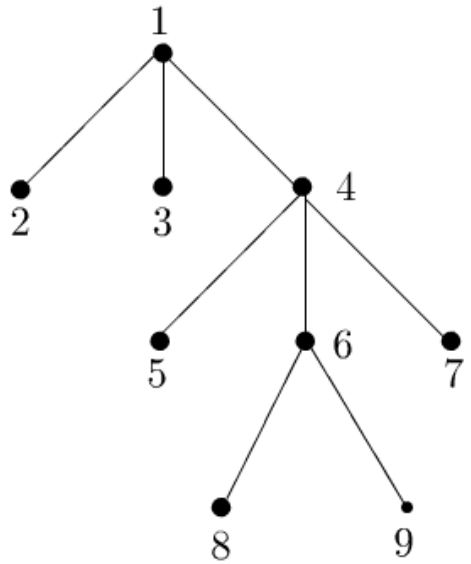
# Membrane structure



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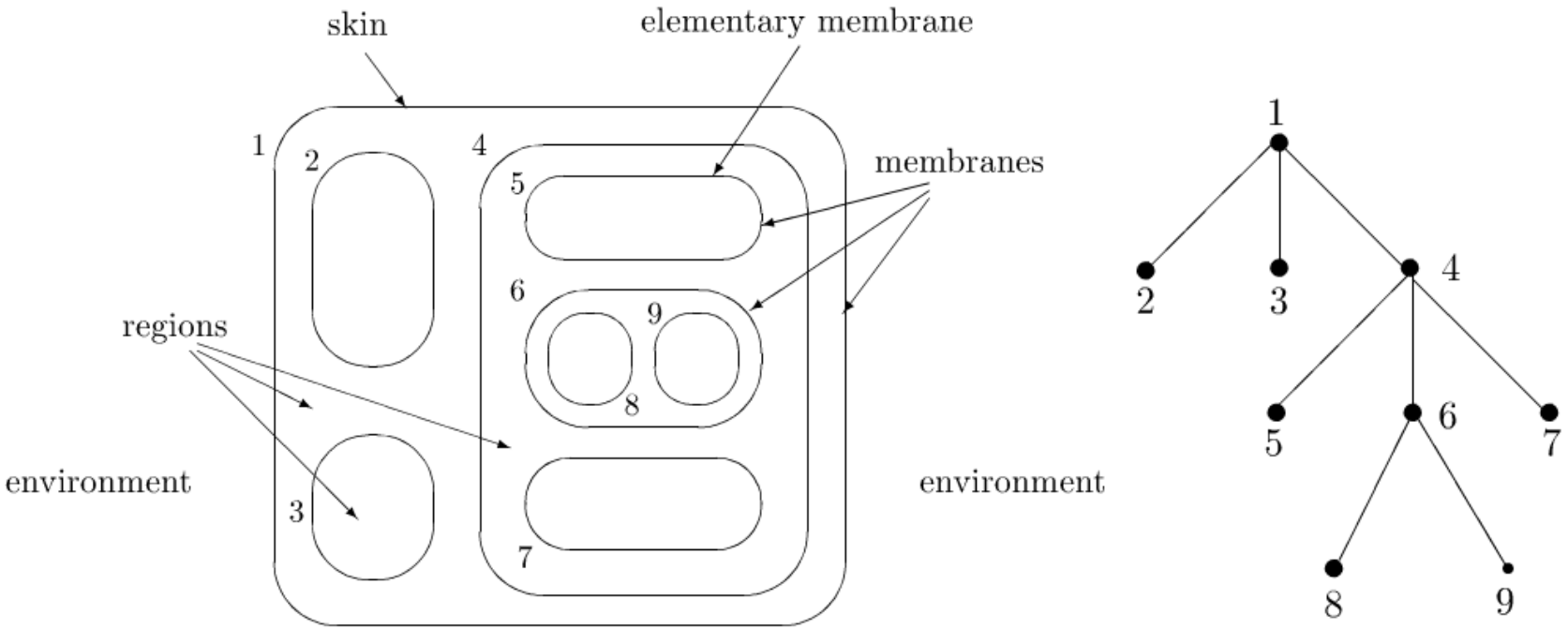
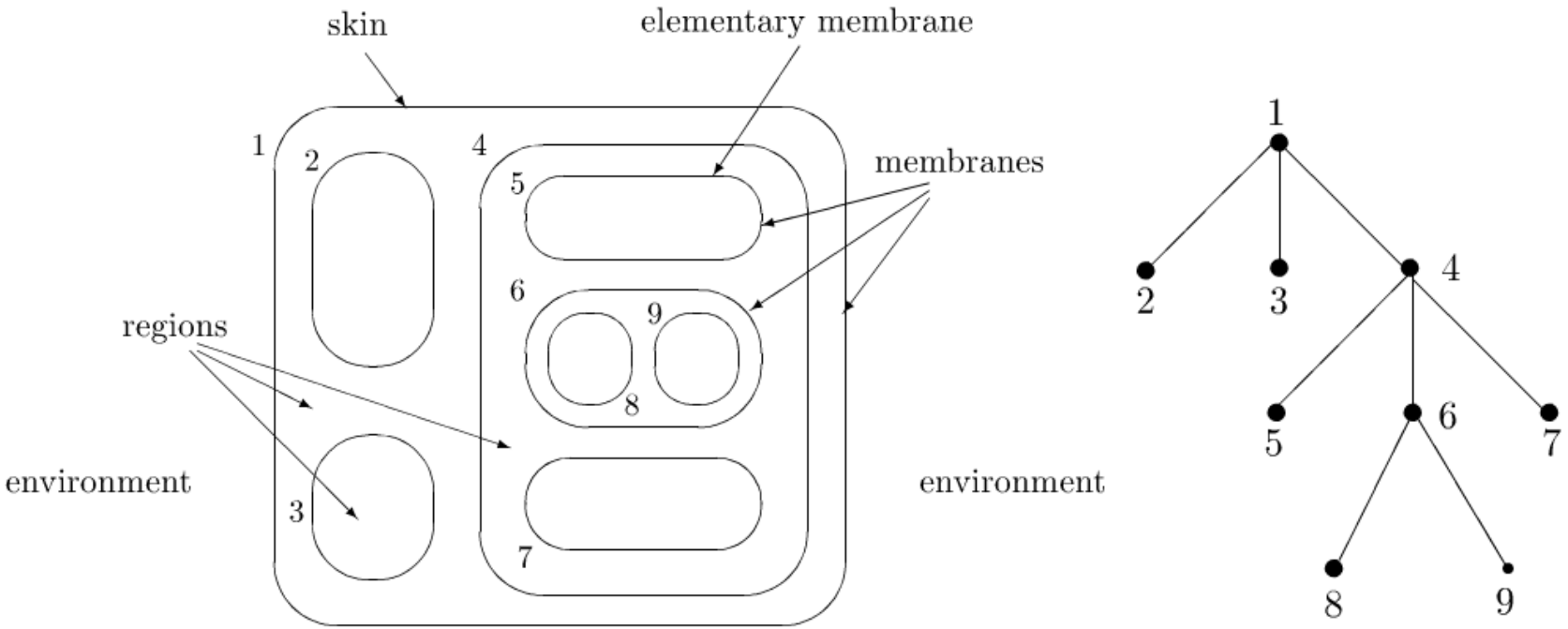


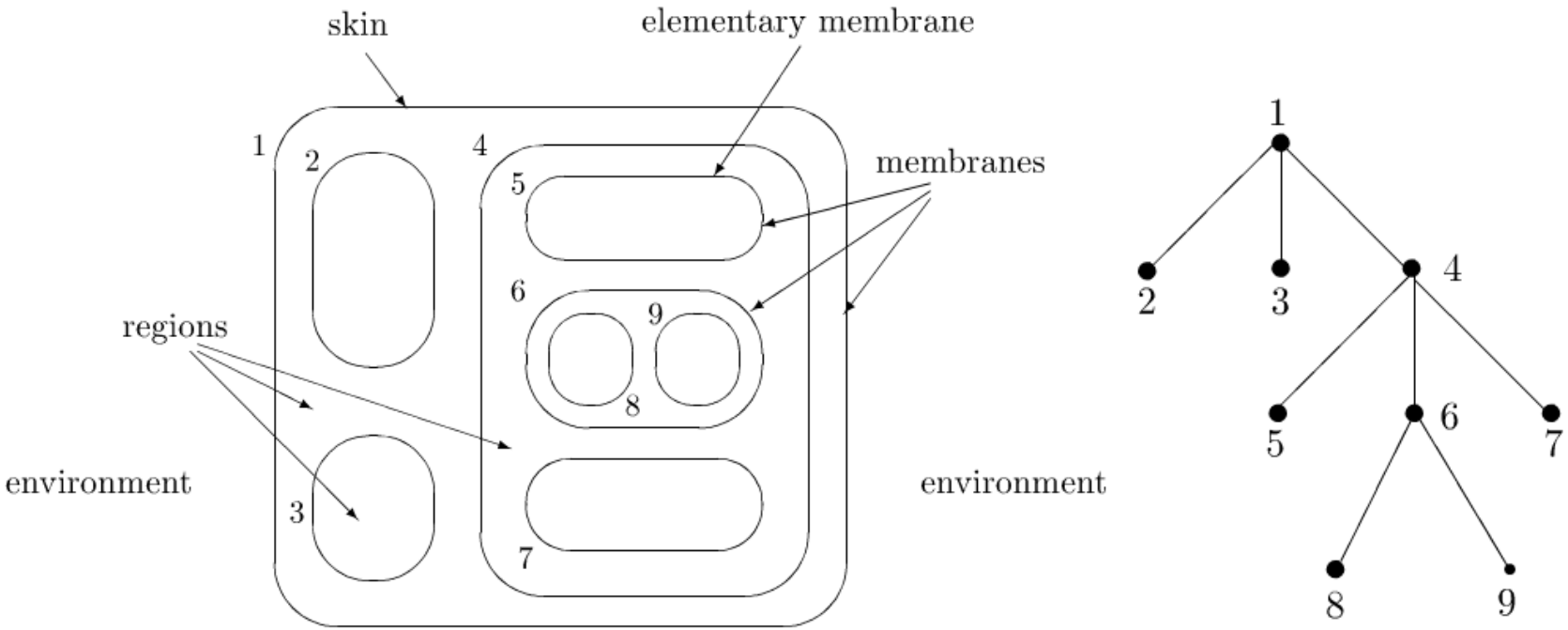

- Multisets

# Membrane structure




- Multisets
- Rewriting rules

# Membrane structure




- Multisets
- Rewriting rules
- Passive vs. Active

# Computation

- Maximal parallel vs. sequential

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- Language
  - generating mode
  - accepting mode

# Multiset vs. set semantics

- How realistic is the counting?
- Effectiveness of verification techniques
- No conflict (objects can participate as reactants in as many rules as they want)

# Reaction systems

TODO: definition

# Set membane systems

- Alhazov [Alhazov, 2006]: multiplicities of objects are ignored R, with active membranes universal
- Kleijn, Koutny [Kleijn and Koutny, 2011]: m̈in-enabledc̈omputational step $\Rightarrow$ sequential R
- maximal parallel $\Rightarrow$ deterministic

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  - $c : V(T) \rightarrow 2^{\Sigma}$

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- $C = (T, I, c)$
  - $I : V(T) \to \{1, \ldots, m\}$
  - $c : V(T) \to 2^{\Sigma}$
- Rewriting rules
  - $u \to w$
  - $u \to w\delta$
  - $u \to [_j v_1]_j v_2$,
    where $u \in \Sigma, |u| \geq 1$, $v_1, v_2 \in \mathbb{N}$ and $w \in (\Sigma \times \{\cdot, \uparrow, \downarrow_j\})$

# Proof of universality

We can simulate the register machine.

- Simple simulation: unary encoding of register values by nested membranes. Linear time overhead and linear number of membranes. Alphabet size: 2 times number of instructions + registers.
- Optimized simulation: binary encoding by nested membrane labels. Logarithmic time overhead and logarithmic number of membranes. Alphabet size: 3 times number of instructions + 5.

TODO: add some slides with example simulation

# Issues with original semantics

- Explicit membrane creation rule
- Sending an object to a child membrane

# inject-or-create

No explicit membrane creation rule TODO: proof of universality

# wrap-or-create

Explicit membrane creation rule which is not blocked by presence of another such membrane TODO: proof of universality Additional control objects, but constant time overhead.


Alhazov, A. (2006).
P systems without multiplicities of symbol-objects.
*Information Processing Letters*, 100(3):124–129.


Kleijn, J. and Koutny, M. (2011).
Membrane systems with qualitative evolution rules.
*Fundam. Inf.*, 110(1-4):217–230.

Thanks for your attention!