

Networks of Bio-Inspired Processors. An introduction

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Networks of Bio-Inspired Processors. An introduction

A NBP is a computational model which

... is inspired by biological aspects (darwinian evolution, DNA recombination, etc.)

... is computationally complete (it has the computation power of a Turing machine)

... is parallel and distributed

... solves NP-complete problems in “polynomial” time

Networks of Bio-Inspired Processors. An introduction

	P systems	NBPs
Computationally complete and universal	OK	OK
Parallel and distributed	OK	OK
Works with strings	OK	OK
Hardware implementations	OK+KO	OK + KO
Works with multisets of data	OK	OK
Software simulators	OK	OK + KO
In vitro/in vivo implementations	KO	KO
Efficient solutions to hard problems	OK	OK

From NEPs to P Systems → Evolutionary P systems (Mitrana, Sempere 2009)

From P Systems to NBPs → **Open problem**

Networks of Bio-inspired Processors

Some bioinspired operators over strings and languages

Insertion Insert a symbol into a string

aaaaa \rightarrow aabaaa

Deletion Delete a symbol from a string

aabaaa \rightarrow aaaaa

Substitution (mutation) Substitute a symbol into a string

aaaaa \rightarrow aabaa

Splicing Splicing rules $r=(u_1\#u_2\$v_1\#v_2)$

$r=(a\#a\$b\#b)$ (abcdaa,bbabcd) \rightarrow (abcdababcd,ba)

Crossover Full massive splicing with empty context

aa $\triangleright\triangleleft$ bb \rightarrow λ , bb, abb, aabb, ab, aab, ...

Hairpin completion Hairpin completion from folded strings

Superposition Complementarity completion from double stranded strings

loop and double loop recombination DNA recombination based on gene assembly

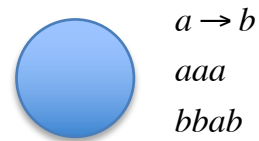
inversion, duplication and transposition DNA fragments modification (operations on substrings)

... etc, etc.

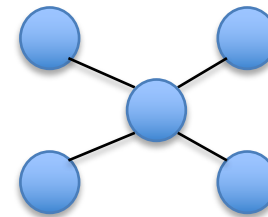
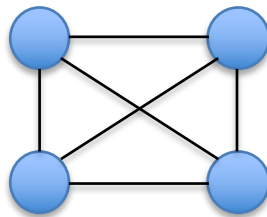
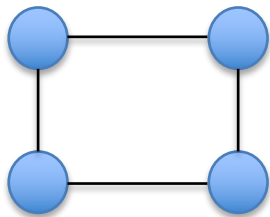
Networks of Bio-inspired Processors

The ingredients to define a Network of Bioinspired Processors

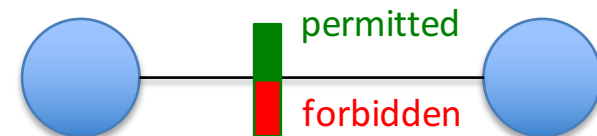
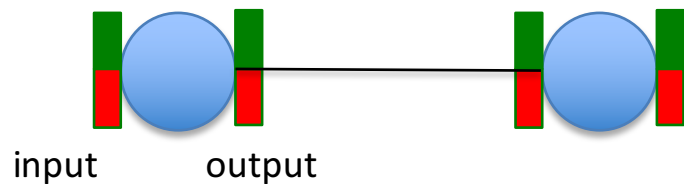
A finite set of processors that apply operations over strings which have been inspired by biomolecular functions and operations in the nature. The processors work with a multiset of strings.



A connection topology between processors in the form of a network.



A set of (input/output) filters which can be attached to the processors or to the connections.



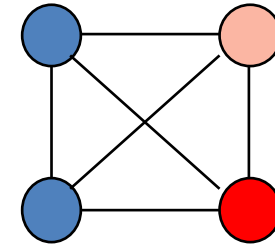
Networks of Bio-Inspired Processors

How does the network work ?

(I) Evolutionary/genetic/splicing steps

$$C_i \Rightarrow C_{i+1}$$

- *Every rule that can be applied is massively applied*
- *No competition between rules. All the rules are applied by using different copies*



(II) Communication steps

$$C_i \mapsto C_{i+1}$$

- *Every processor sends all the filtered strings to its neighbours*
- *Every processor receives and stores filtered strings*
- *Strings that are sent but not received are lost*

(III) Network at work

$$C_0 \Rightarrow C_1 \mapsto C_2 \Rightarrow C_3 \mapsto C_4 \dots$$

Networks of Bio-Inspired Processors

Towards a full general model ...

A bio-inspired processor over V is a 5-tuple (op, PI, FI, PO, FO) , where:

op is a biologically inspired operation over strings

$PI, FI \subseteq V$ are the input permitting/forbidding contexts of the processor

$PO, FO \subseteq V$ are the output permitting/forbidding contexts of the processor

- op encapsulates the operation parameters
- PI, FI, PO and FO can be empty so the filters are attached to the connections

Networks of Bio-Inspired Processors

Accepting Networks of Bio-Inspired Processors

$$\Gamma = (V, U, G, N, \beta, \gamma, x_I, x_O)$$

where

V and U are the input and network alphabets

$G=(X_G, E_G)$ is an undirected graph without loops

$N: X_G \rightarrow BP_U$ associate a bio-inspired processor to every node in G

$\beta: X_G \rightarrow \{s, w\}$ associates a filter predicate to every node

$\gamma: E_G \rightarrow 2^U \times 2^U$ associates a filter (P_e, F_e) to every edge in the graph

x_I, x_O are the input and output nodes

Networks of Bio-Inspired Processors

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