Ethogenetics and the Evolutionary Design of Agent Behaviors

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«Ethogenetics»
Purpose of our research

«Ethogenetics» is our approach to the design

of evolvable agent behaviors in a situated system

It implies the use of a structure for producing the behaviors of the agents, with the following requirements :

(1) allow for agents behaviors to be of any complexity

(2) be understandable and manipulable directly by a human designer (for bootstraping, observation, modifications...)

(3) be evolvable through a «blind» evolutionary process

(e.g. Darwinian selection) which is a kind of unsupervised learning

(4) allow cumulative adaptation in order to allow (3)

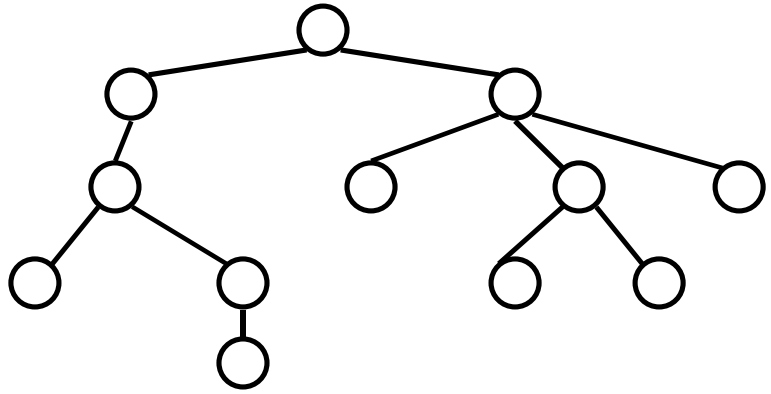
Overview of evolutionary approaches

Genetic Algorithms (Holland)

parameters
for a predefined behavior

+ continuity genotype ⇒ phenotype
- poor expressive power

Evolutionary and Genetic Programming (Fogel,Koza)



executable structure (program tree,...)

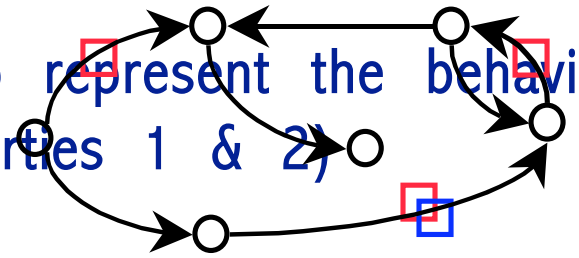
+ automatic behavior design
- strong structural constraints (syntactical issues)

The *ATNoSFERES* Model

Existing evolutionary approaches (e.g. Genetic Algorithms, Evolutionary and Genetic Programming...) do not meet the 4 requirements simultaneously !

The model we propose as an illustration of Ethogenetics is based on:

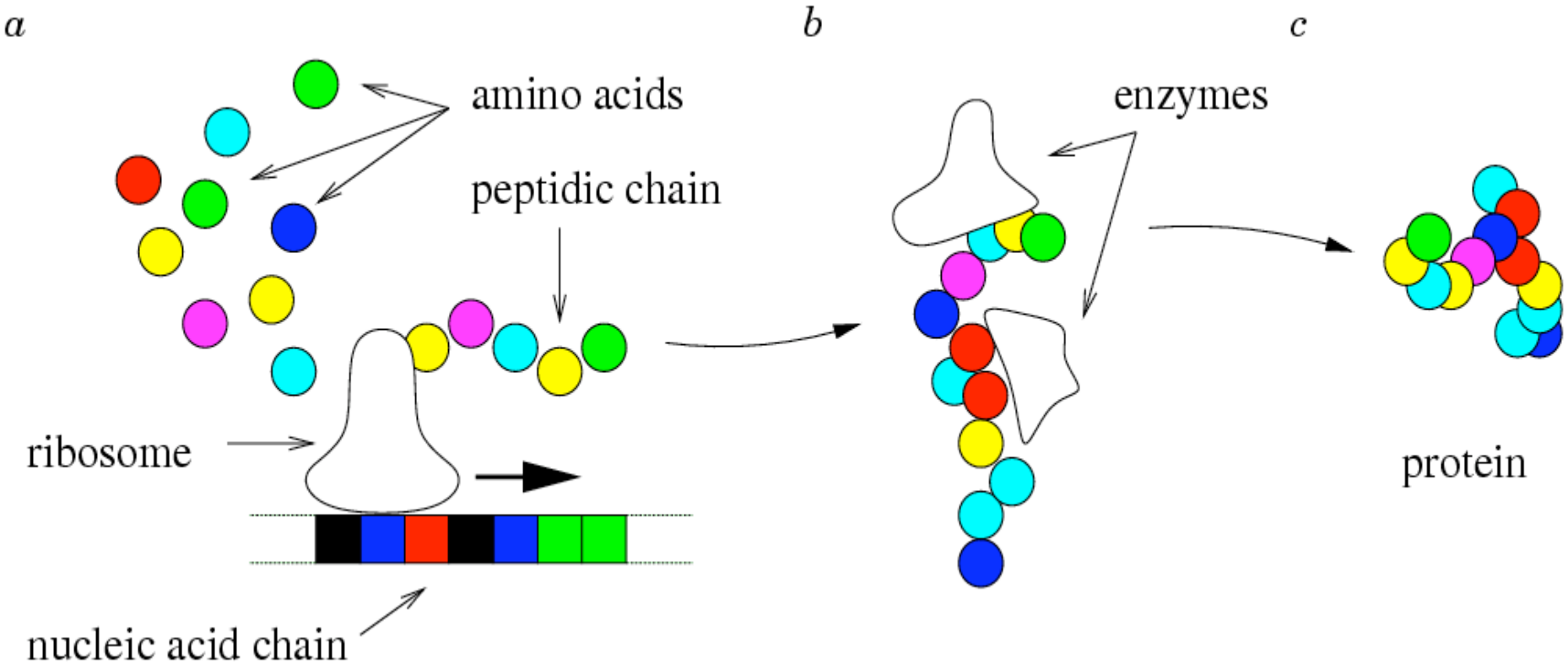
- a non-deterministic automaton to represent the behavior of any agent (ATN Graph; ensures properties 1 & 2)



- a bitstring as hereditary substratum (gene) for building this automaton

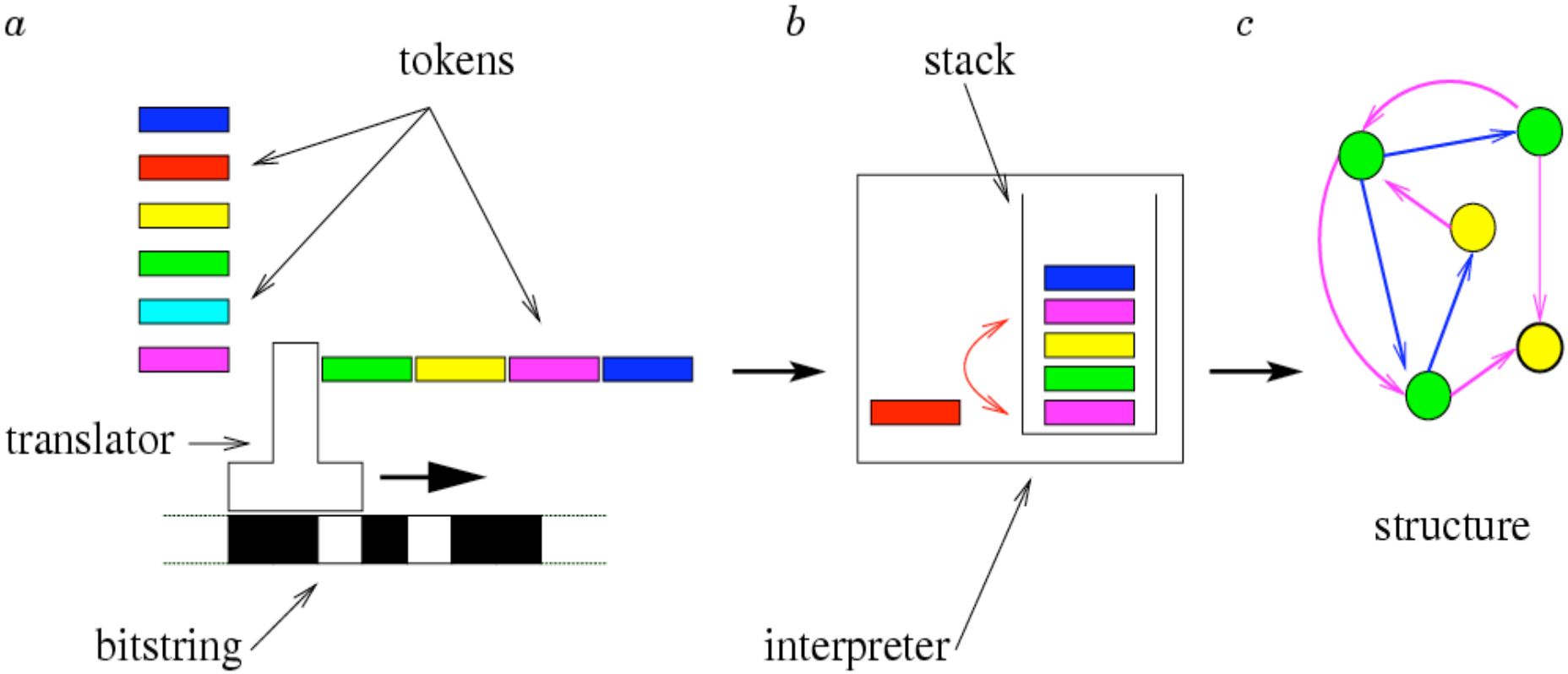
The *ATNoSFERES* Model

Biological Gene Expression



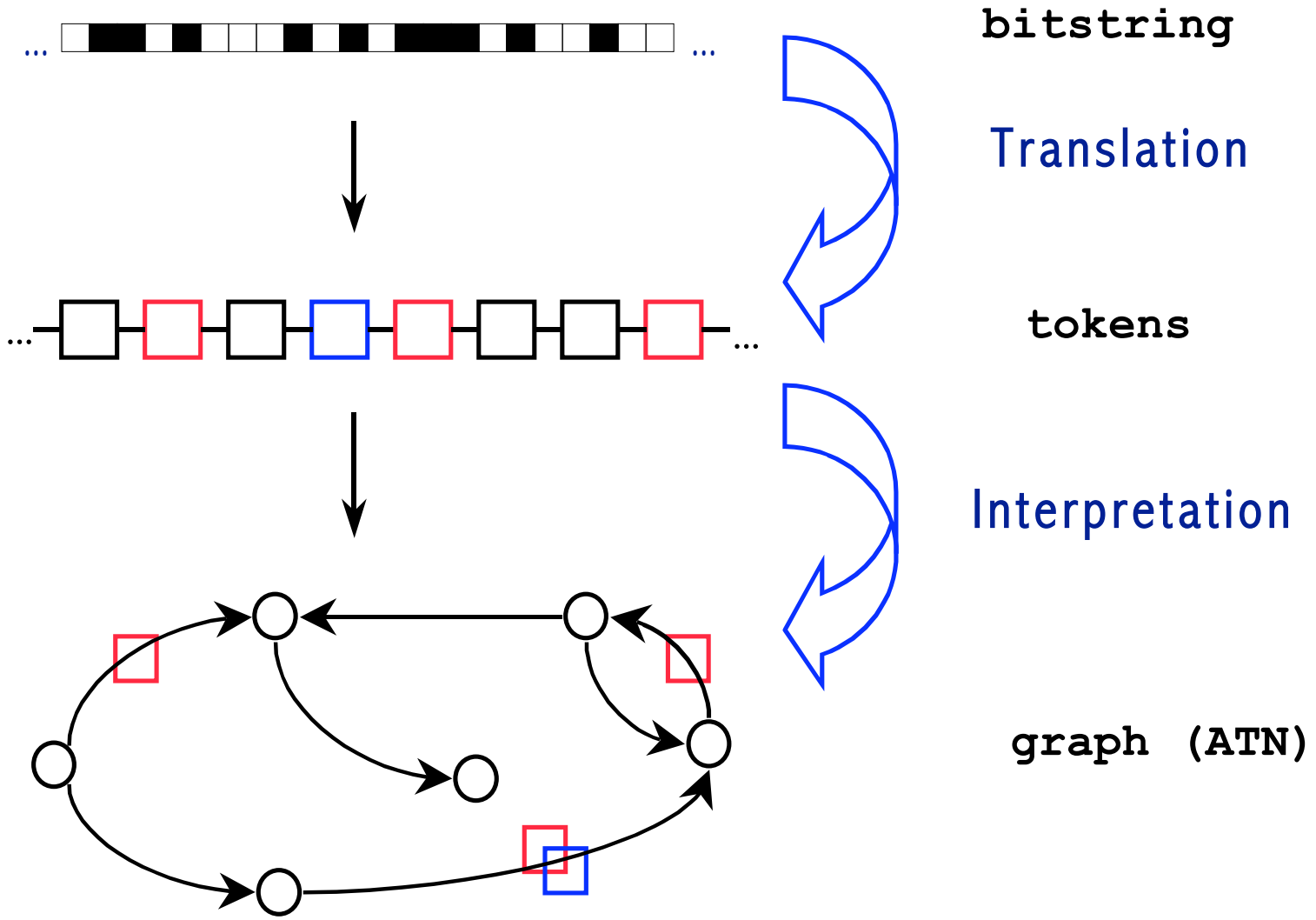
The *ATNoSFERES* Model

Stack-based Gene Expression



The *ATNoSFERES* Model

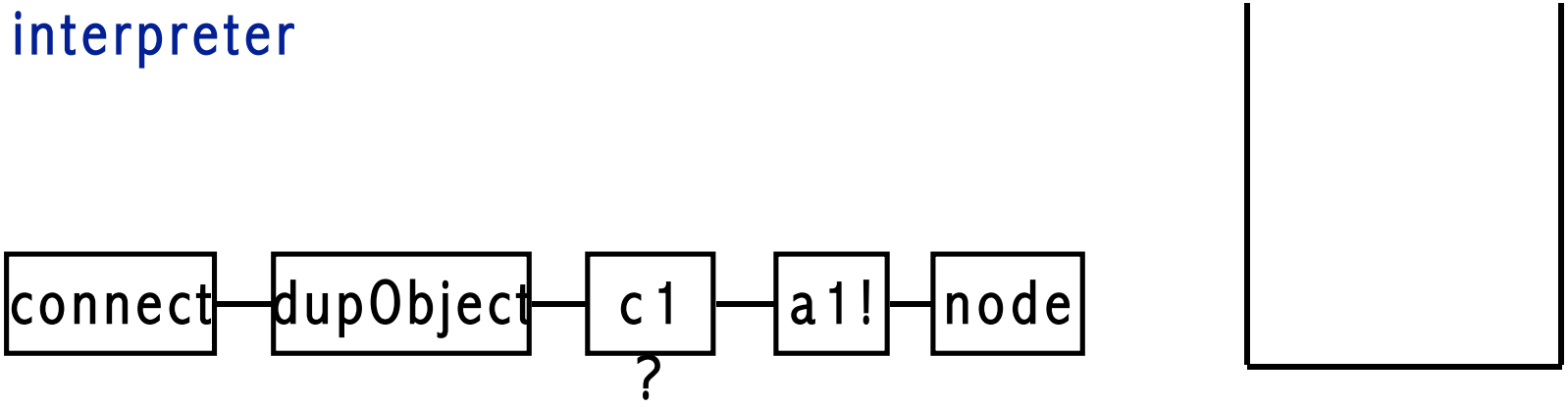
Agent architecture



The *ATNoSFERES* Model

ATN Building (1)

interpreter



ATN

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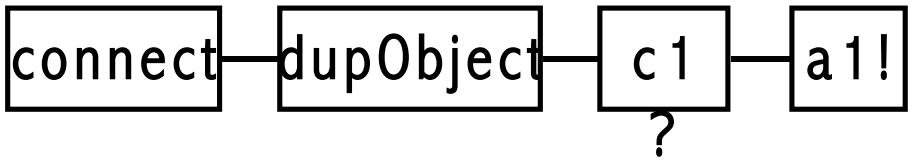
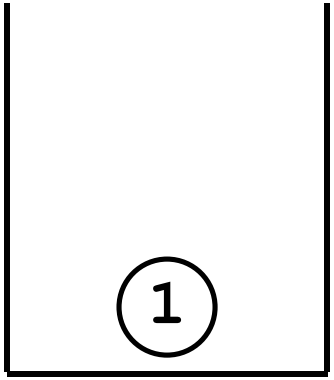
The *ATNoSFERES* Model

ATN Building (2)

interpreter



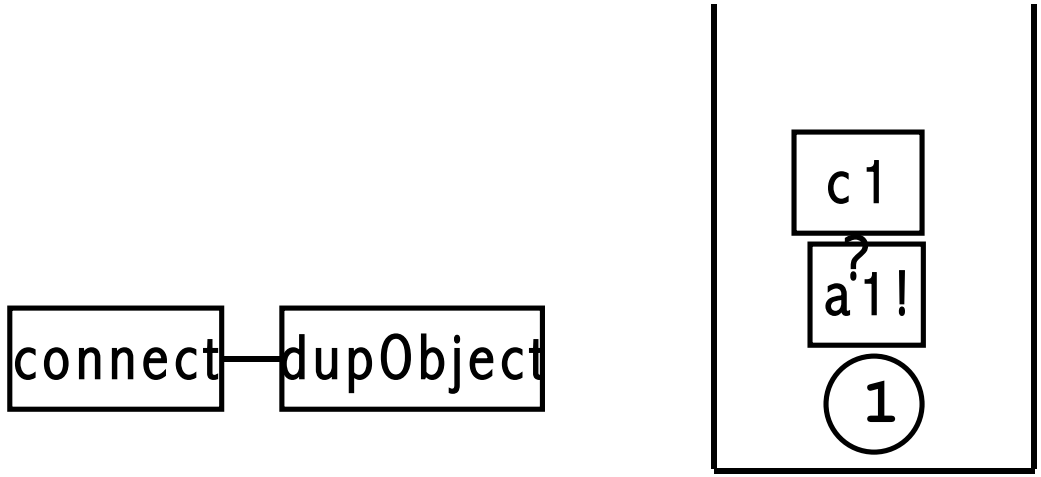


ATN

The *ATNoSFERES* Model

ATN Building (3)

interpreter

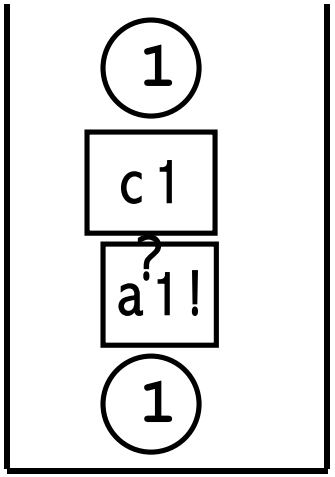


ATN

The *ATNoSFERES* Model

ATN Building (4)

interpreter



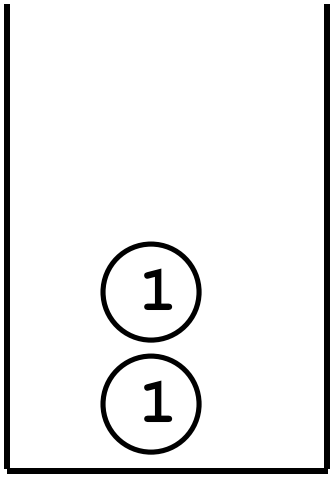
connect

ATN

The *ATNoSFERES* Model

ATN Building (5)

interpreter



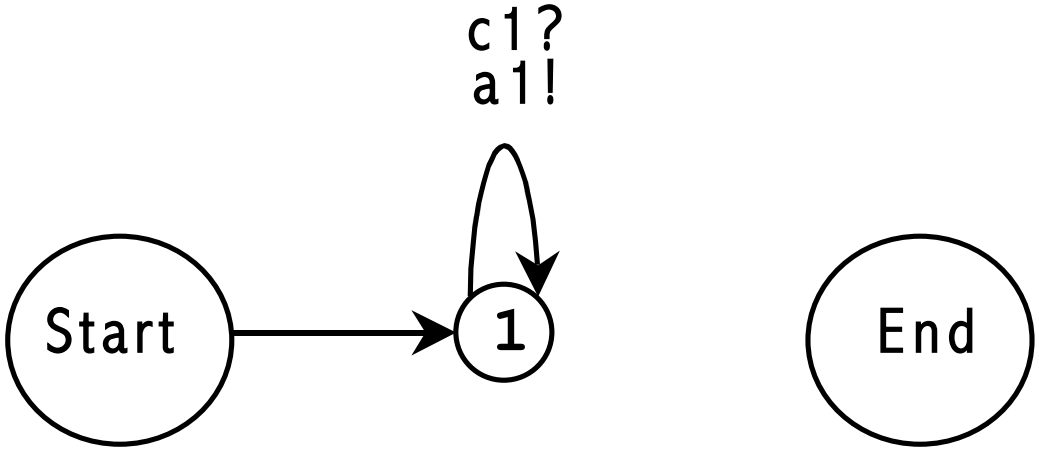
ATN

The *ATNoSFERES* Model

ATN Building (6)

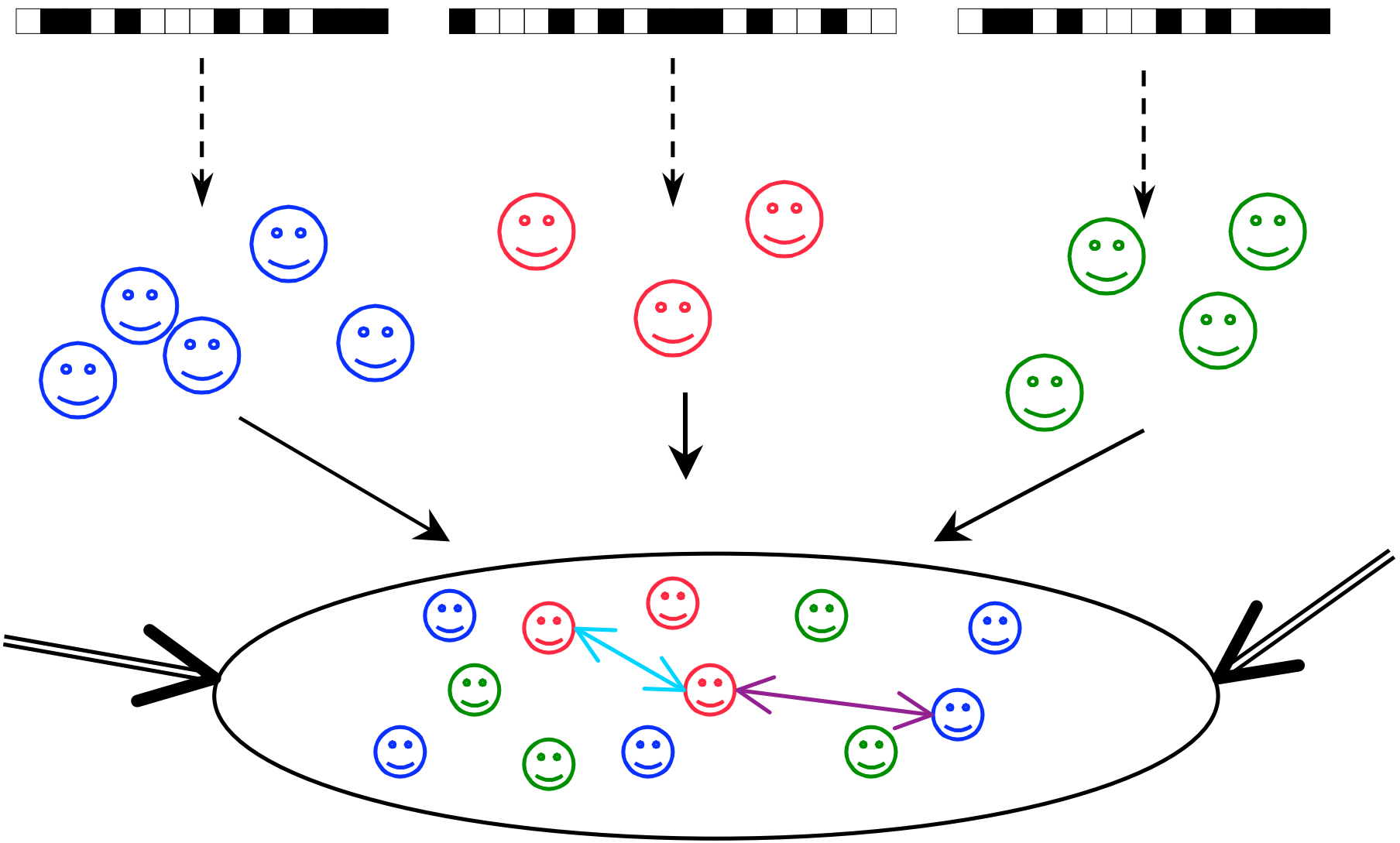
interpreter

ATN



The *ATNoSFERES* Model

Multi-agent architecture



Conclusions

Properties of the ATNoSFERES Model

- Automatic building of agents behaviors
- No specific hypothesis regarding the cognitive abilities of the agents
- Any genotype (bitstring) produces a consistent automaton
- Continuity between genotype (bitstring) and phenotype (ATN) through redundancy, locality and properties of the stack-based gene expression
- Completeness of the ATN-building language
- Large structural plasticity (bitstring, ATN), see article
- Validation of the model through simple problems
- Ongoing experiments on predators/preys issues

Perspectives

- **Ethogenetics** is an approach that focuses on the specific features of agents and multi-agent systems

- Next experiments:
  - Formation-based navigation in a group of robots (part of the **MICRobES** Project: http://miriad.lip6.fr/microbes/)
  - Use of adaptive MAS to investigate emodiment in robots

- Additional research on evolvability

ATNoSFERES Homepage

For additional information, please see:

http://miriad.lip6.fr/atnosferes/