University of Msila

FACULTY OF MATHEMATICS AND INFORMATICS

DEPARTMENT OF COMPUTER SCIENCE

Agent-oriented simulation

Introduction

- Agent-oriented simulation is now increasingly used in various sectors, gradually replacing different microsimulation techniques
- This is due, in part, to its ability to understand very different models of individuals,

from very simple entities through “reactive” agents to more complex entities (in the form of cognitive agents).)

- After the object revolution, software engineering is moving in the direction of a design in terms of interacting units. Cognitive agent cannot be reduced to an object Agents are mainly used to model complex systems such as:
- ⇨ Brain
- ⇨ Climate
- ⇨ Animal societies (ants)
- ⇨ Internet

Introduction

- Multi-Agent Simulation is well-suited for complex systems composed of multiple entities. It involves separating these entities, which will be represented by agents, defining their various behaviors and interactions, then evolving the agents over time. The study involves analyzing the progression of the overall system in response to actions produced by the agents and their interactions..

- A Multi-Agent simulation system is a set of agents and rules for interaction between them.
- Each agent is capable of individually assessing its situation and making decisions based on a set of rules.
- It can execute various behaviors relating to the represented system.
- The agents can then be able to evolve, allowing unanticipated behaviors to appear.

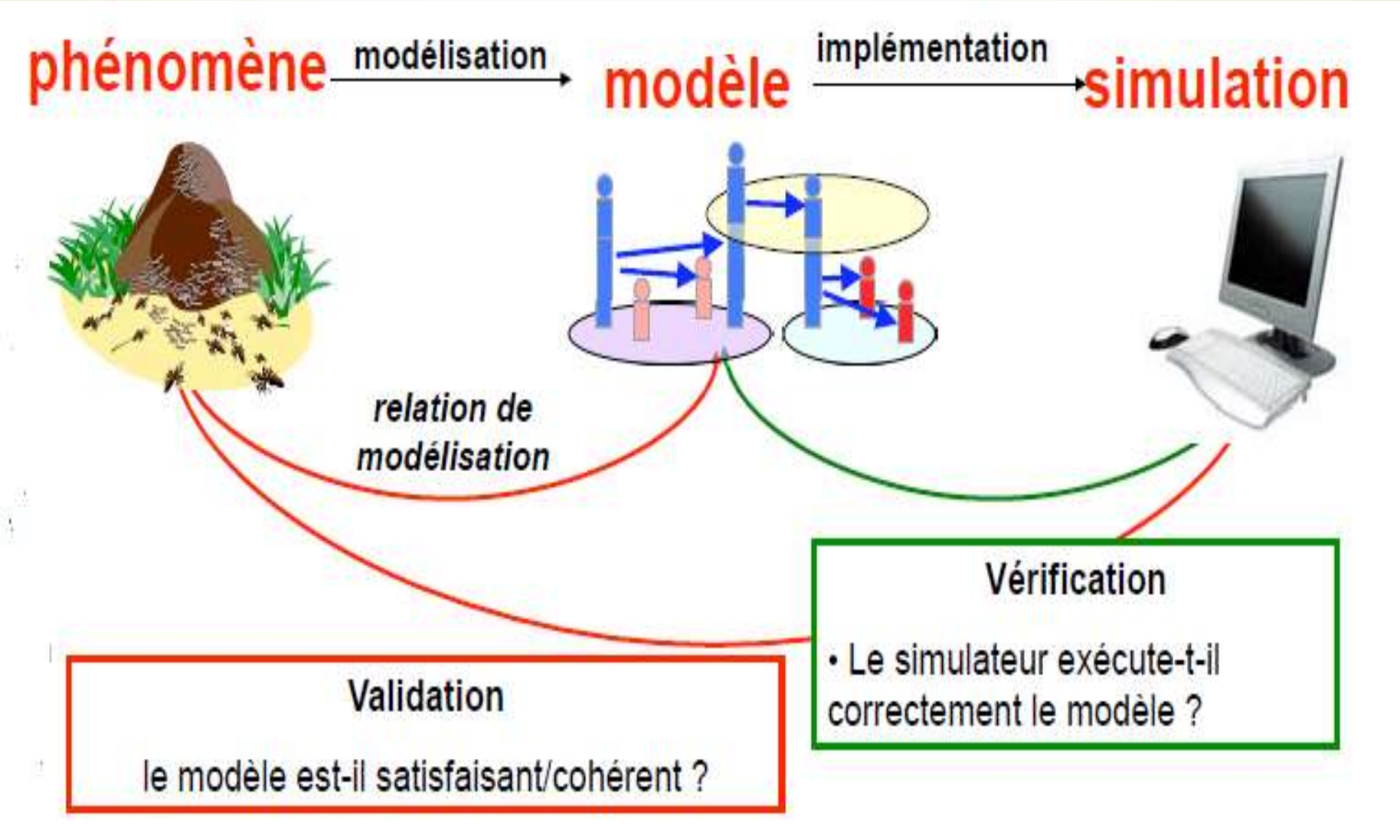
Multi agent systems

Computer Model

- To define the system to be modeled, you'll need to identify:
  - its entities,
  - Information (data),
  - the processes involved in handling this data,
  - and the flows or exchanges of information between the entities.

- It's both a conceptual representation and a set of instructions for programming and simulating the system.
- This involves using algorithms and modeling techniques such as UML (Unified Modeling Language).

Computer Simulation



Agent-based simulation

- "Agent-based models
- Early work began in the early '90s Has undergone significant development in recent years
- Idea Use models centered on entities and their interactions
- Consider that the overall dynamics of the system arise from the interactions between these entities."

Agent-based simulation

- Create an artificial world composed of interacting agents.
- Each agent is described as an autonomous entity.
- The behavior of agents is the result of their observations, internal tendencies, representations (possibly), and interactions with the environment and other agents (communications, stimuli, direct action, etc.).
- Agents act and modify the state of their environment through their actions.
- The results of their interactions are observed as if in a laboratory (virtual laboratory concept)."

Methodology for Multi-Agent Simulation

- The modeling of a phenomenon from a Multi-Agent perspective involves four steps, but before that, it is essential to take a thorough snapshot of the system to be simulated and understand its operation in detail. Then:

1.Decomposition of the phenomenon into a set of discrete autonomous elements whose interactions reproduce the phenomenon. It is noteworthy that this preliminary step requires an already distributed vision of the phenomenon to be modeled (one of the simulation's objectives is precisely to determine the relevant elements or levels to study).

2.Modeling each of these elements as an agent: In this phase, a necessary choice is made regarding the theory to be used to define the agent's knowledge, functional capabilities, behaviors, and interaction modes with other agents.

3.Definition of the space or environment in which these agents operate and the laws governing it. Defining the environment allows for refining the description of possible actions by agents, as well as their means of communication. Agents and the environment are often defined concomitantly.

Application of Multi-Agent Systems (MAS) to simulation

- **Ethology:** ants (sociogenesis, organization of work), Fish (movement, behavior, ...), etc.
- **Biology**: plant growth simulation, simulation of plant/animal interactions, ...
- **Epidemiology**: analysis of foot-and-mouth disease epidemics
- **Geography:** analysis of city development (SimPop)
- **Transportation management**: simulation of airports, train stations, road centers, ... and so on...

Multi-Agent Systems (MAS) platforms for simulation

- **Simulation:**
  - Swarm
  - RePast
  - Massive (commercial and very expensive)
  - Cormas: cormas.cirad.fr
  - NetLogo, StarLogo
  - MadKit
  - TurtleKit
  - Moduleco
  - Mason
  - JADE
  - Aglet

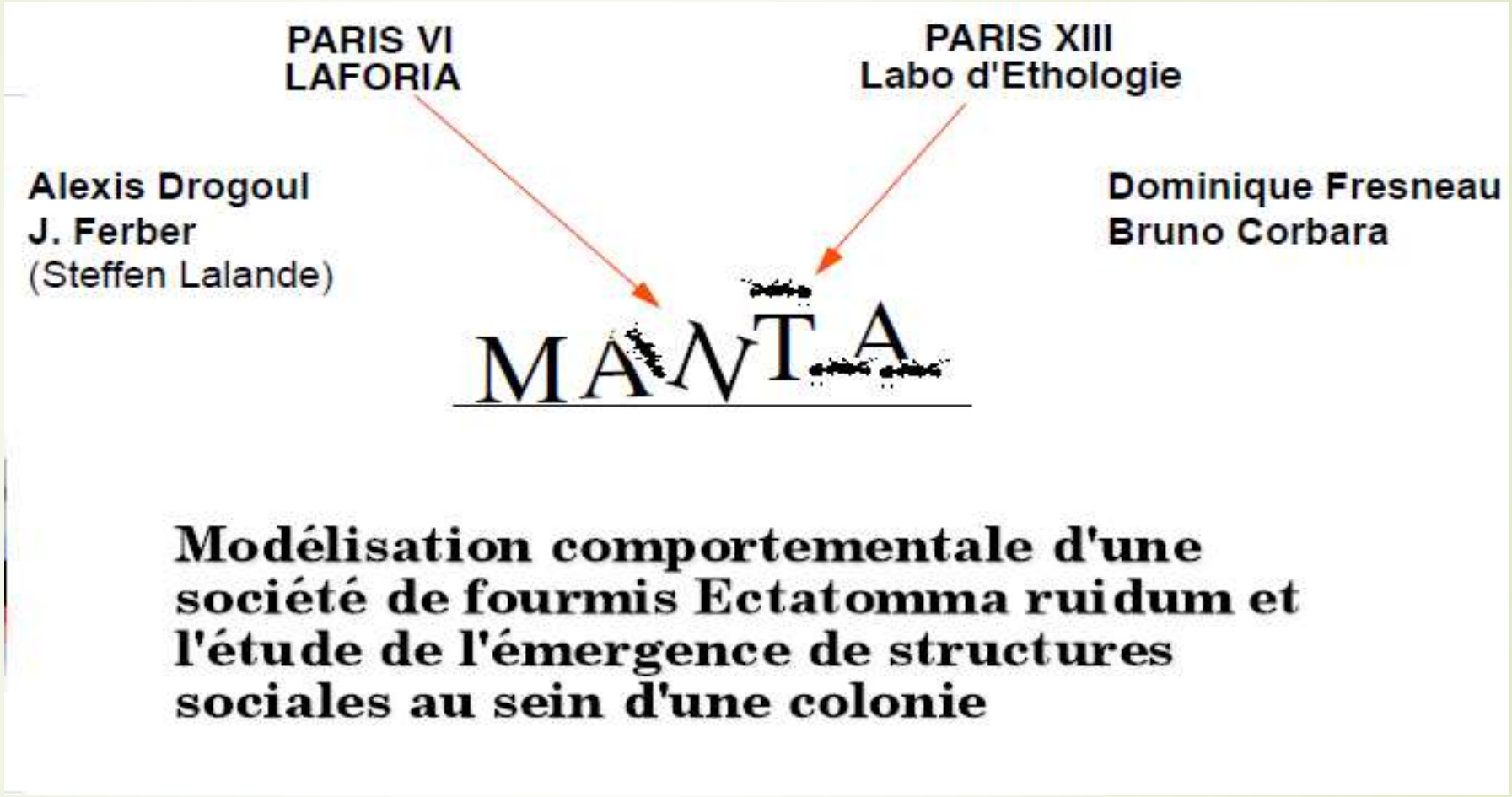
Modeling:

- Mimosa

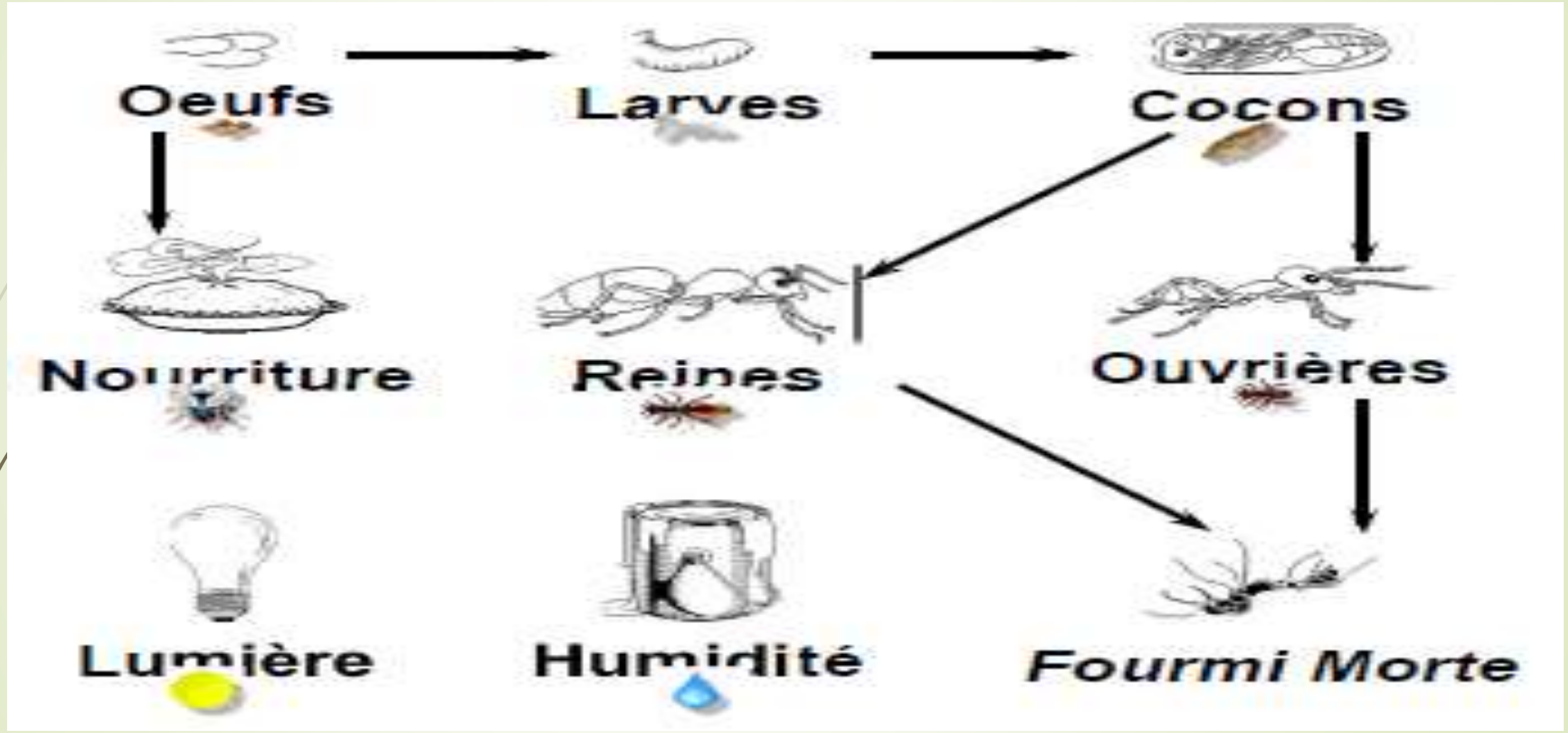
Disadvantages of the agent-based approach

- **Robustness of Results**
- Errors in coding can lead to false correlations or results.
- Complex program! Agent-based models (ABMs) generally involve a proliferation of parameters, making fine-tuning delicate.
- ⇨ Difficulty in analyzing results, the behavior of the simulation.
- How to explain emerging results from the behaviors of (numerous) agents that have had numerous interactions?
- **Evaluation of the Simulation** There is no general methodology for assessing the outcome of an agent-based simulation.
- ⇨ Lack of standards for agent-based simulation platforms.
- Makes comparison between models, between studies, more challenging.

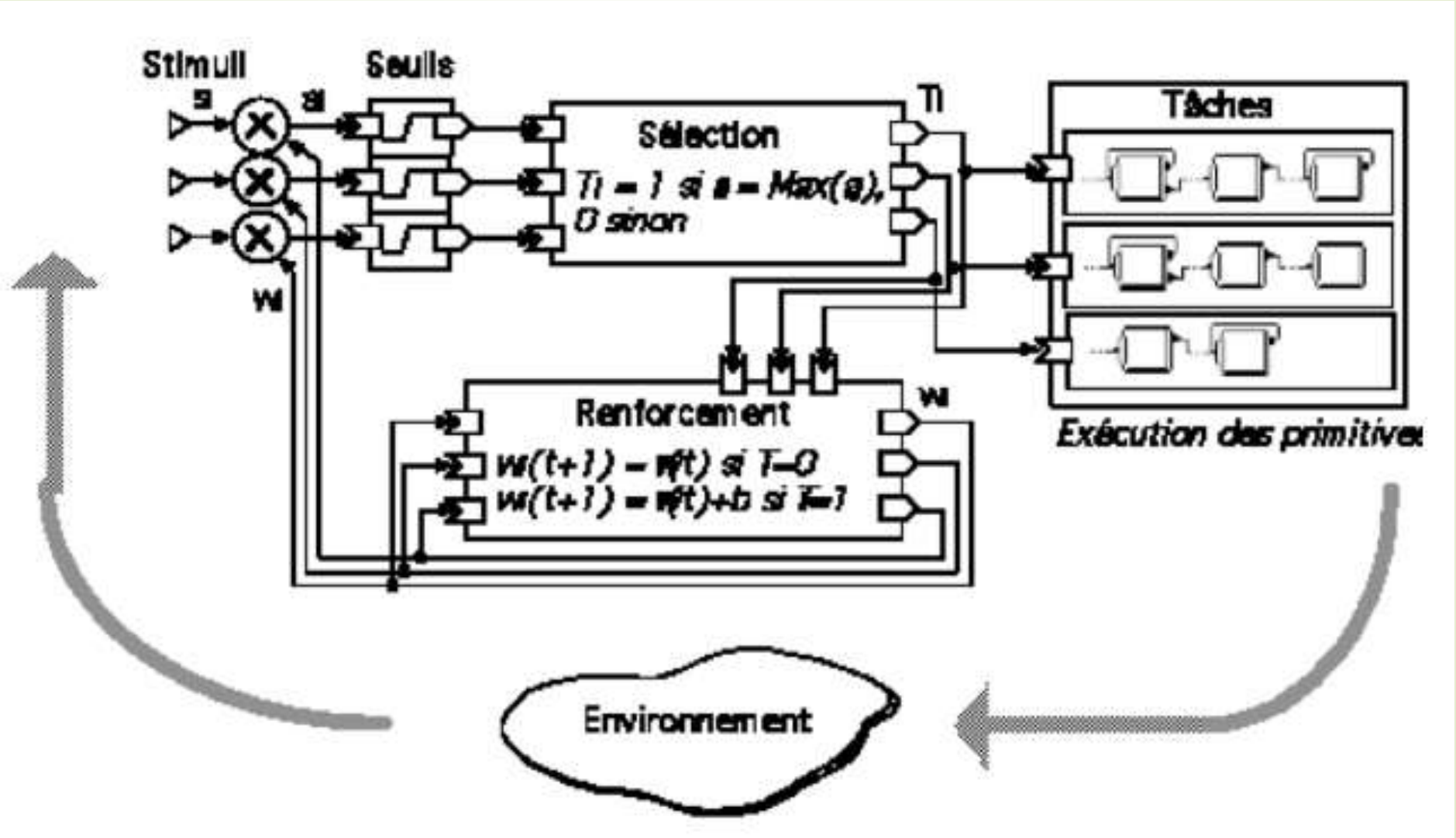
Example: the Manta Project



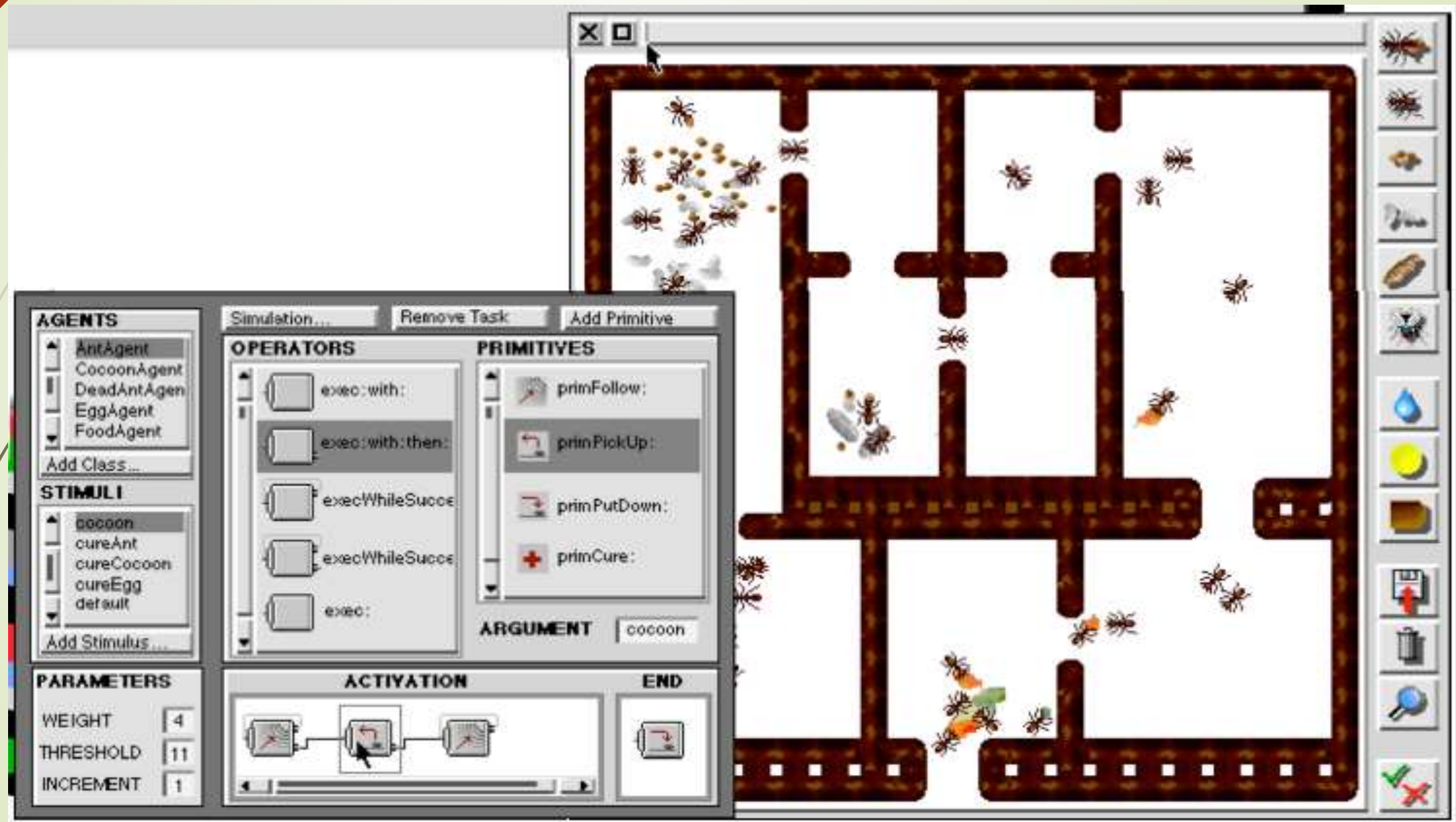
Manta Agents



Agent's behaviour



Manta: The Virtual Laboratory



Manta Experiments