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Agent-Based Modelling in Pharo Using Cormas

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CIRAD is the French agricultural research and cooperation organization working for the sustainable development of tropical and Mediterranean regions.

My Objectives



Inform you about ABM and Cormas



Get you **excited** about the cool things
that we can do with it



Encourage you to **participate** in our effort



Part 1:

Agent-Based Modelling

Let's look at the Birds



<https://youtu.be/X0sE10zUYyY>

Central Questions of ABM



Q1: How do individuals that act on their own create beautiful emerging patterns?

.....

Q2: How do those patterns of behavior then feed back to affect those individuals?

Some Applications

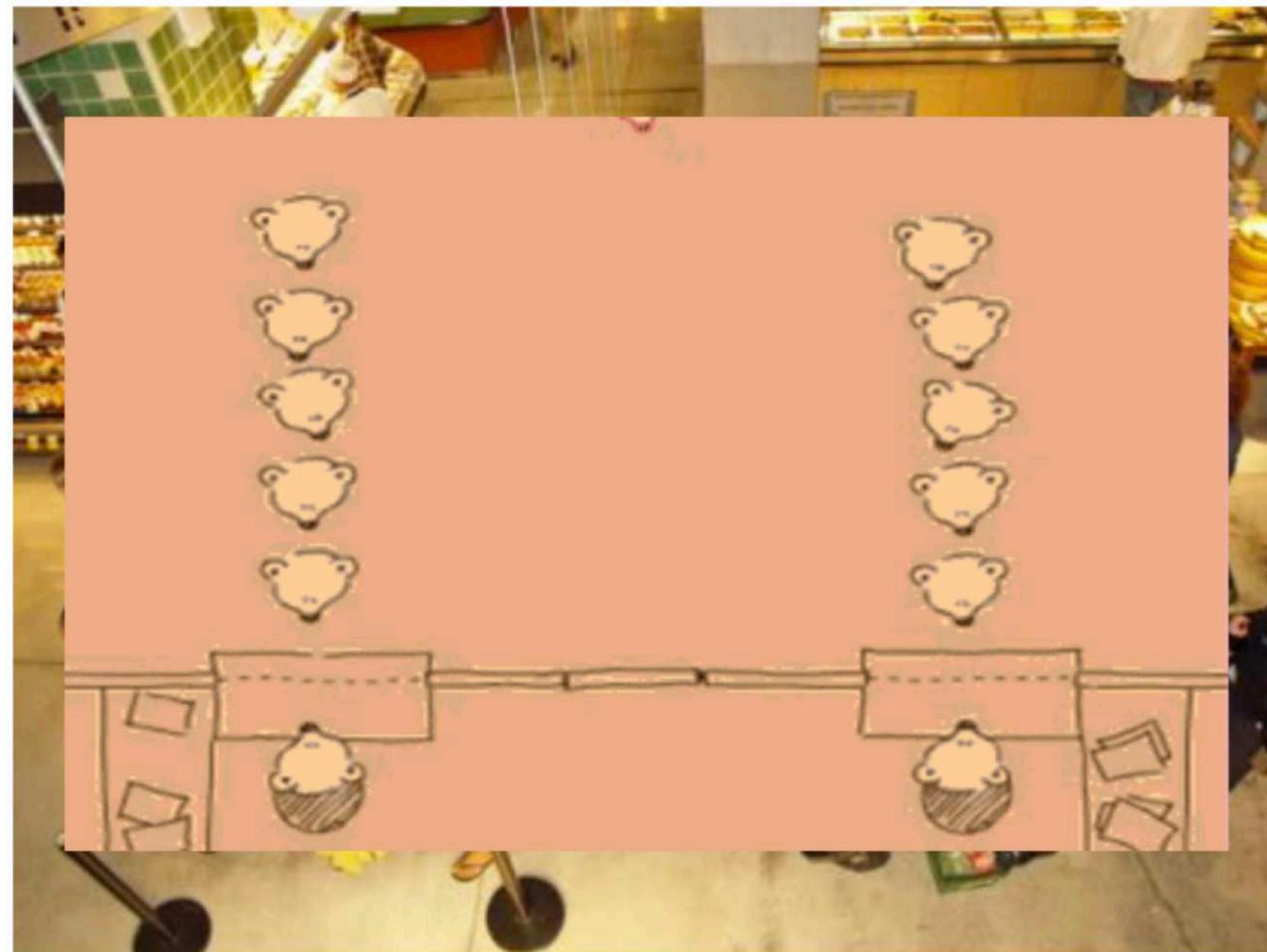


Which Queue to Choose?

Real world

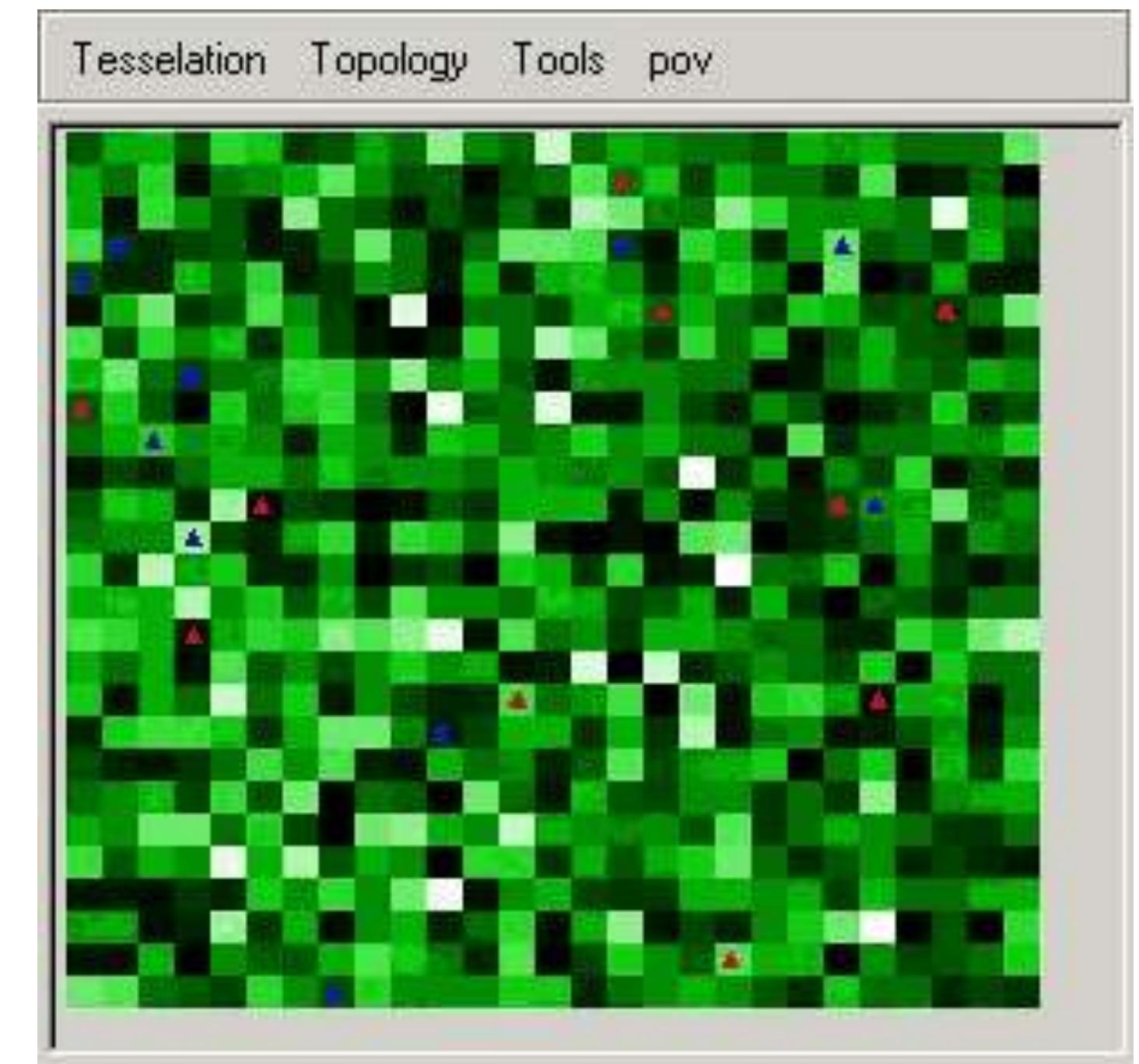
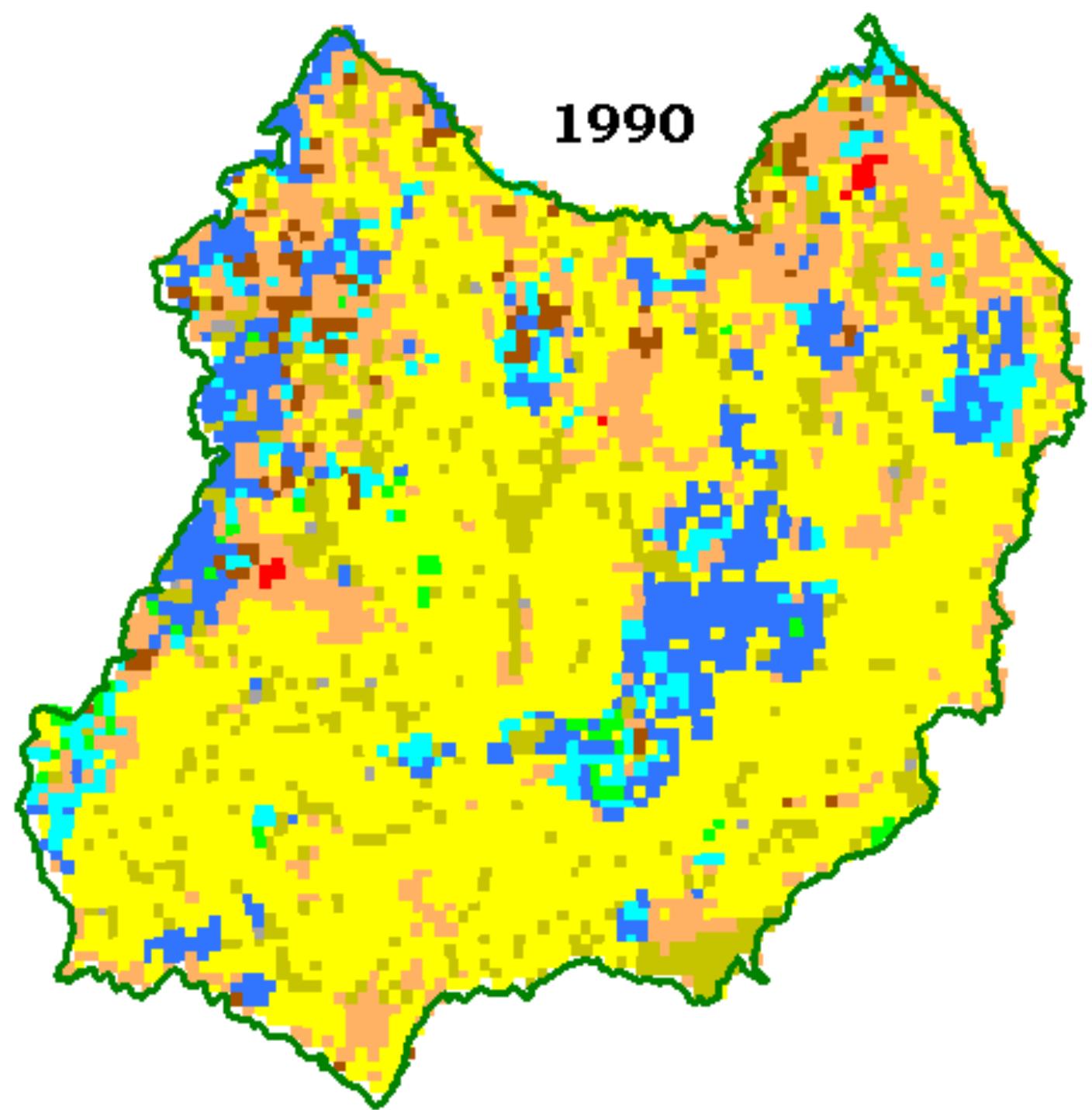
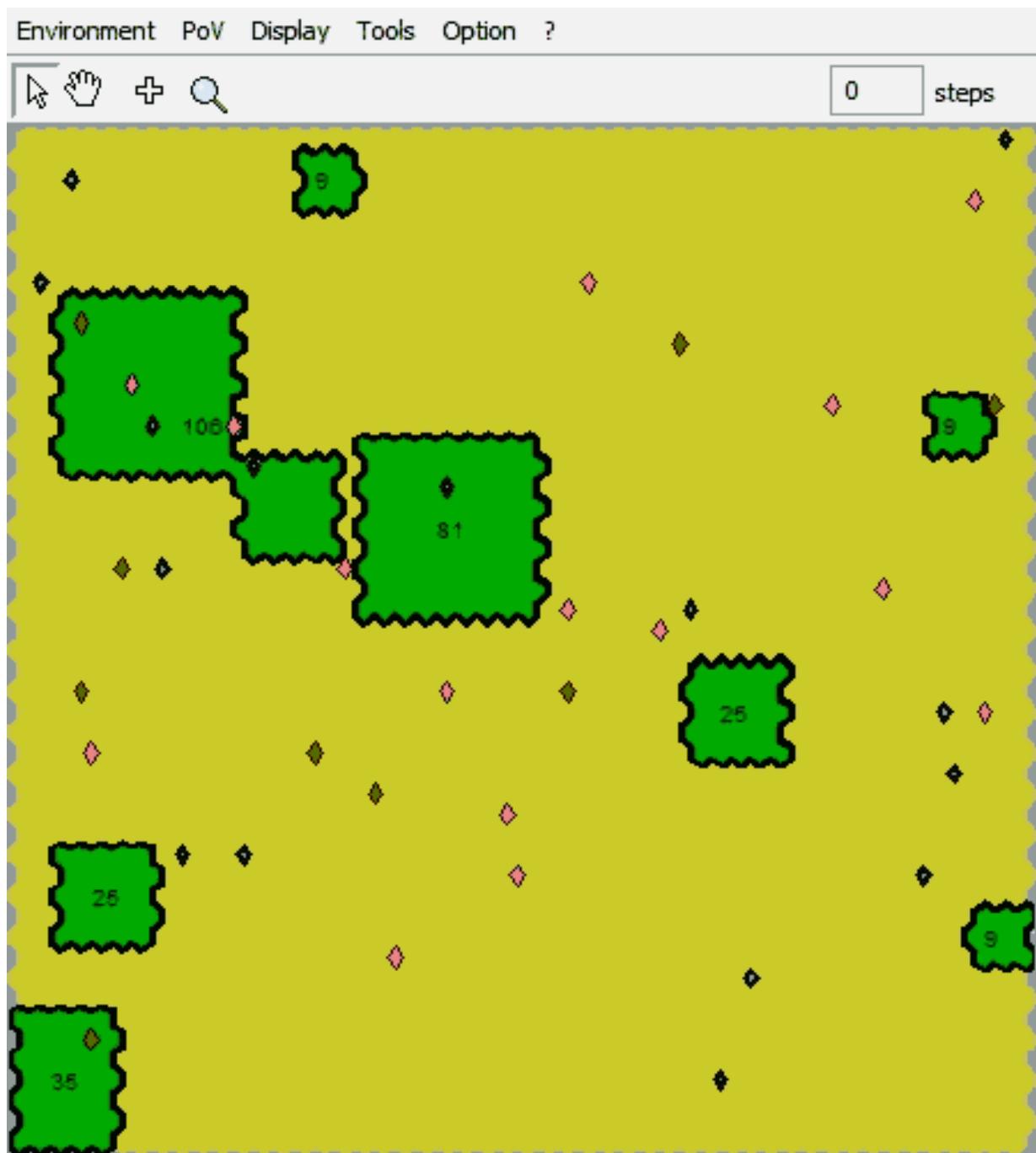


Model



Your Own Little Lab

Test theories, explore interactions ...



ABM Platforms



The image displays three side-by-side screenshots of Agent-Based Modeling (ABM) platforms:

- NetLogo:** Shows a simulation of ants on a textured surface. A control panel on the left includes sliders for "Number of ants" (200), "Evaporation of the signal (unit/cycle)", and "Rate of diffusion of the signal (%/cycle)". Below the simulation are two plots: "Percent Similar" (y-axis 0-100, x-axis time 0-36.3) and "Number-unhappy" (y-axis 0-454, x-axis time 0-36.3). A command center at the bottom contains the observer and command sections.
- CORMAS:** Features a large central logo and the text "Common pool Resources and Multi-Agent Simulations". It includes a UML Class Diagram Editor interface, a "CORMAS - DundiModel (1.0)" simulation window with controls for "Initialize", "Forward", and "current step (1000)", and a "CORMAS - Probes - DundiModel (1.0)" window showing line graphs for various metrics over time.
- Pharo:** Shows a "CORMAS - DundiModel (1.0) - Space Interf" interface with a map visualization of agent distribution across a grid.

The background image shows a vast, terraced landscape of rice fields, likely in Southeast Asia. The fields are arranged in numerous small, rectangular plots that follow the contours of the land, creating a pattern of green and yellowish-brown colors. Some fields appear to be harvested, while others are still green. Small clusters of traditional houses with thatched roofs are scattered throughout the fields. The terrain is hilly and covered with vegetation.

Part 2: Cormas Platform

Cormas Platform



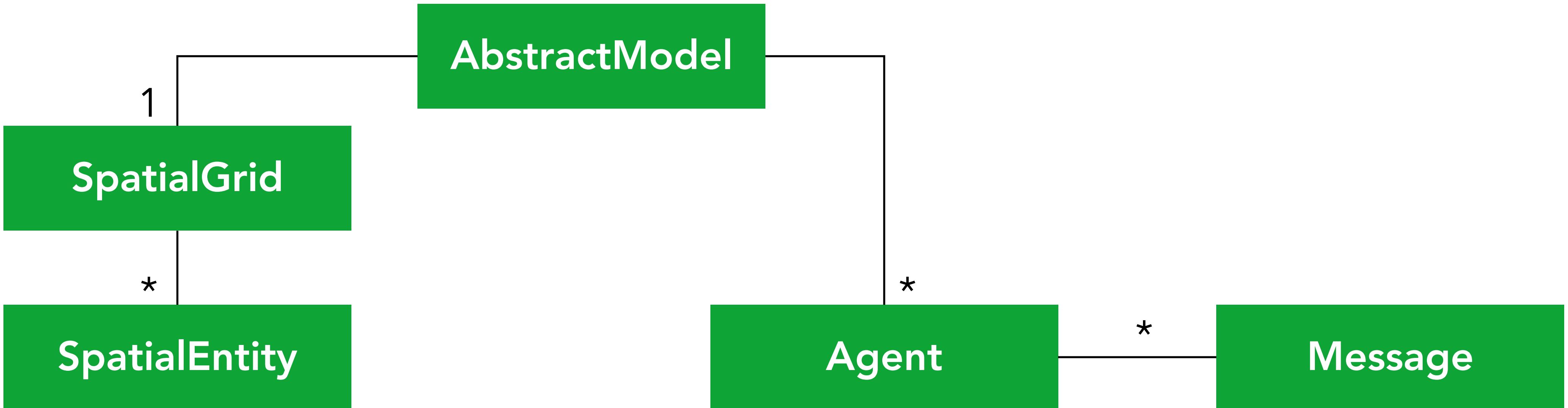
Common pool Resources
and Multi-Agent Simulations

- ✓ Multi-agent simulations
- ✓ Developed in 90s by Green Unit
- ✓ Originally implemented in VisualWorks
- ✓ Ongoing migration to Pharo

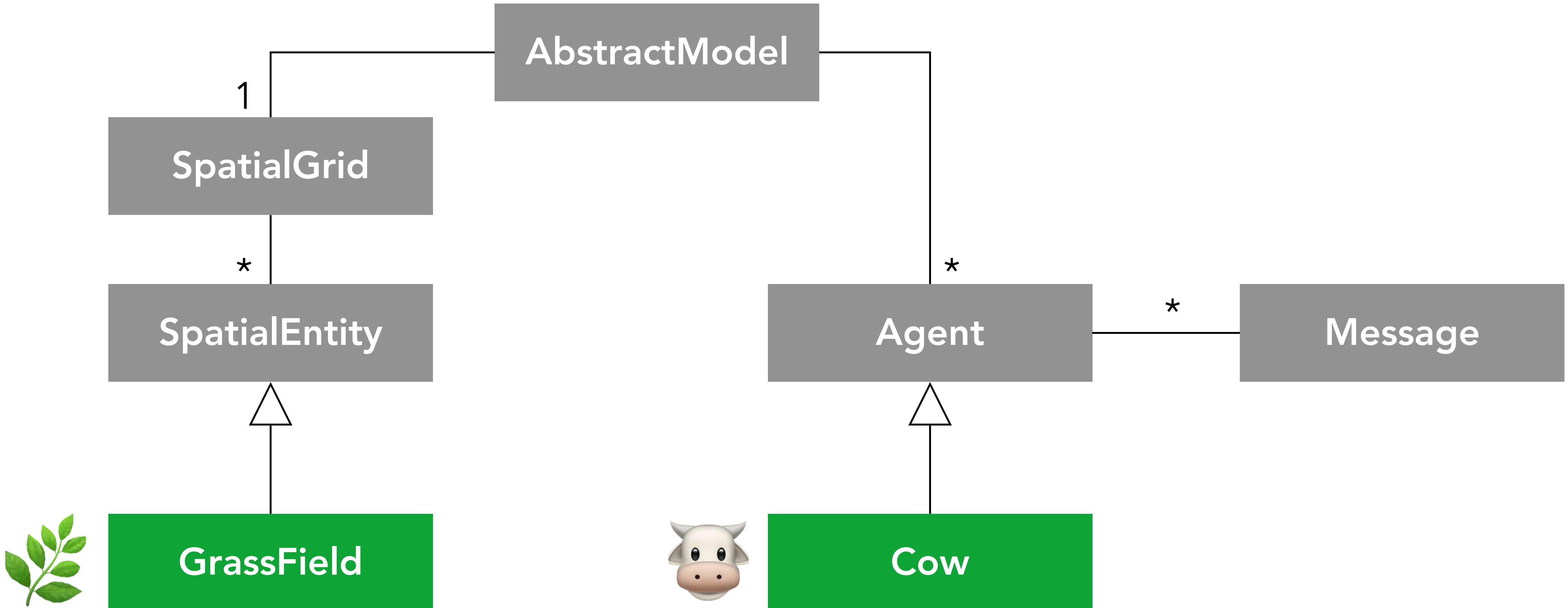
The screenshot displays three main components of the Cormas Platform:

- Cormas : Building Agent Simulations With Pharo**: A browser-based application for creating agent-based models. It includes a sidebar with navigation links like "Home", "About", "Documentation", "Tutorials", "Examples", "API", and "Issues". The main area shows a code editor with Pharo Smalltalk code and a preview window.
- Contents**: A table of contents for the book "Cormas : Building Agent Simulations With Pharo" by Etienne Delay, Pierre Bommel, Bruno Bonté, Nicolas Bonté, and Sébastien Gaudin. The table of contents lists chapters such as "A first step in modelling and simulation", "Building a Cormas Model from scratch: the stupid model", "Building a Cormas Model from scratch: fireman", "Beyond the Basics: Lifecycle and Tools for Cormas Models", and "Analysis and experiments Cormas models".
- ISSUE TRACKER**: A Jira-like interface for managing issues. The header shows "cormas / Projects / Cormas Development". The main view lists issues categorized by priority (Priority 2: Emergency, Priority 3: Urgent, Priority 4: Not Urgent) and difficulty (Easy, Very Easy, Medium, Hard). Issues include "Visual glitches in Pharo 10 after installing Cormas #550", "Some tests are timing out #552", "Assertion failure in *CreationDate tests #551", "Methods contain halt #174", "Port Scenario settings (a.k.a. CMSpecInitialValueChoose #507", "Default entity name method not working for classes with #564", etc.

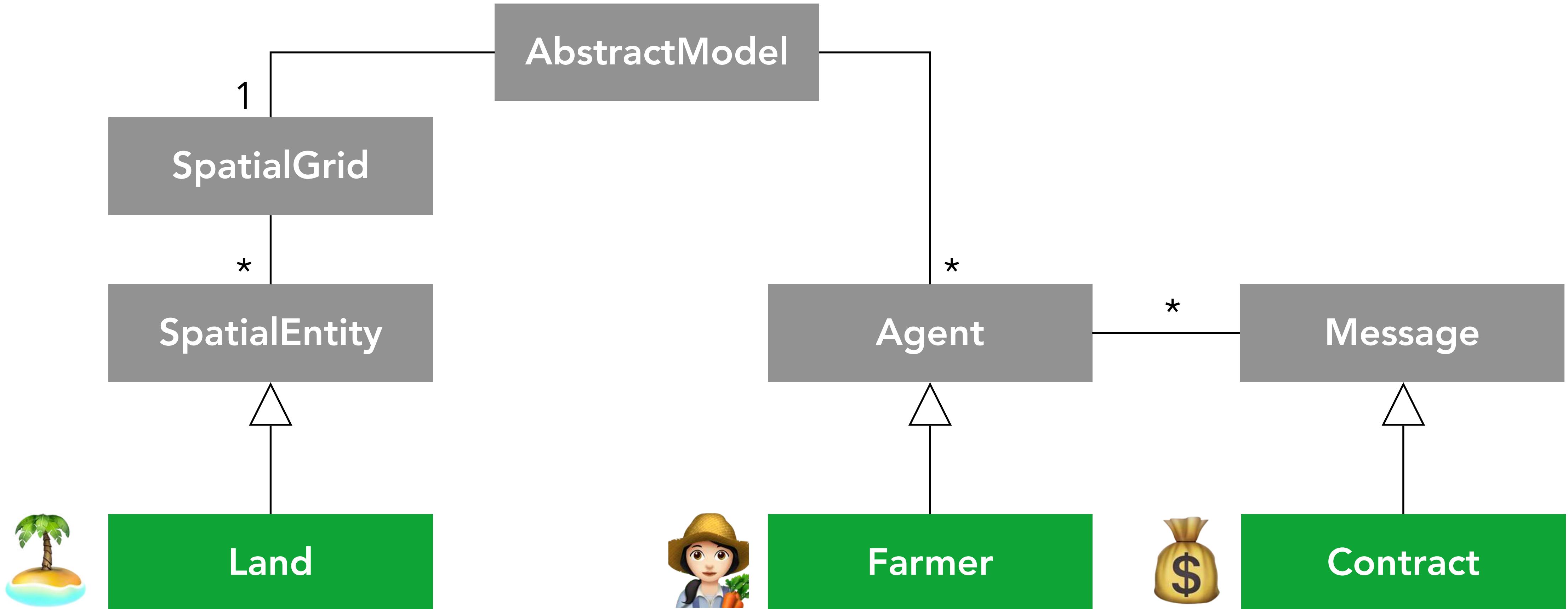
Basic Classes



Located Agents



Communicating Agents



What Makes Cormas Unique?



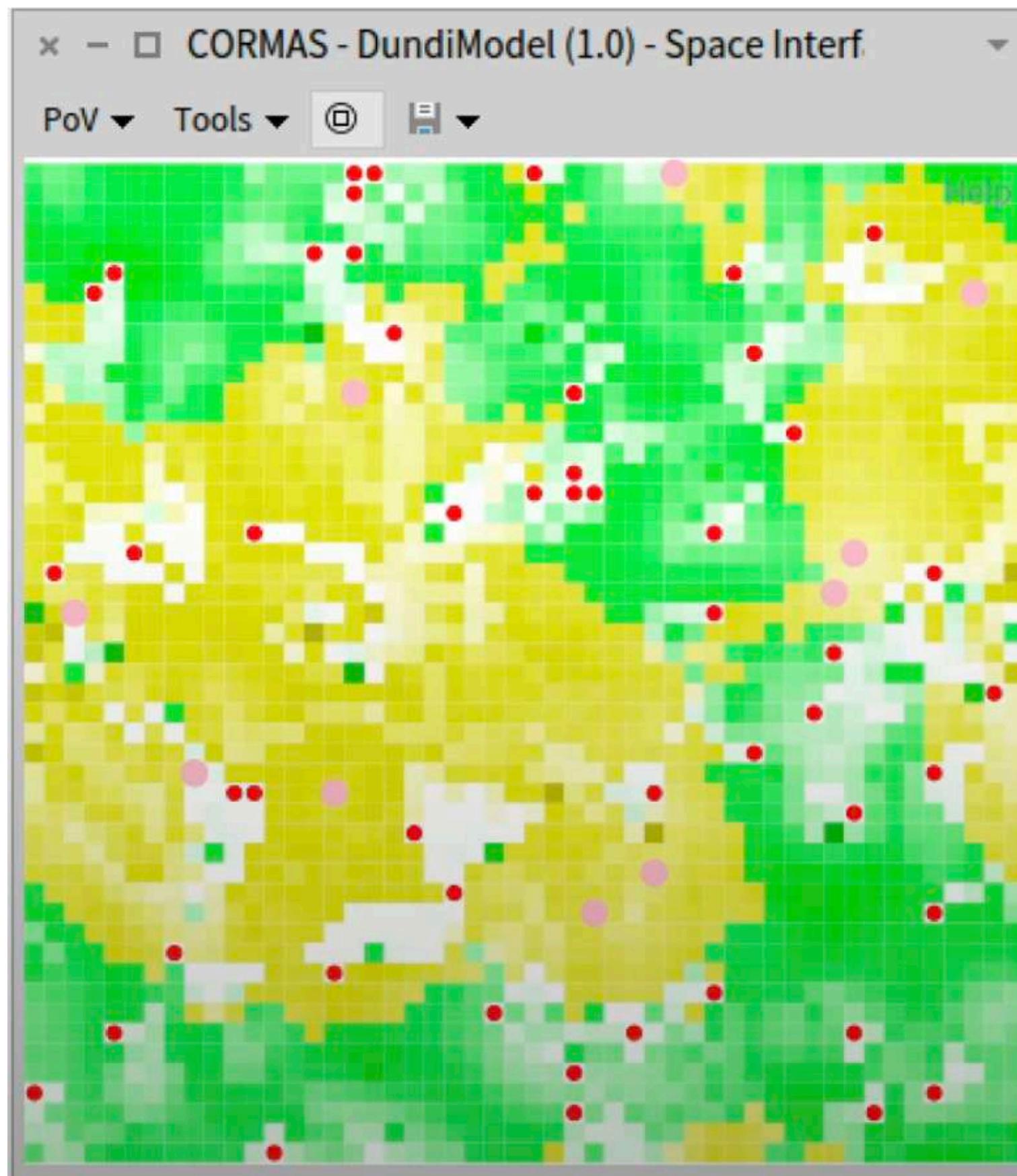
Cormas is **interactive** and particularly well adapted for the **participatory** modelling.

It provides different « points of view », allows users to inspect and control specific agents, allows stepping back in time.

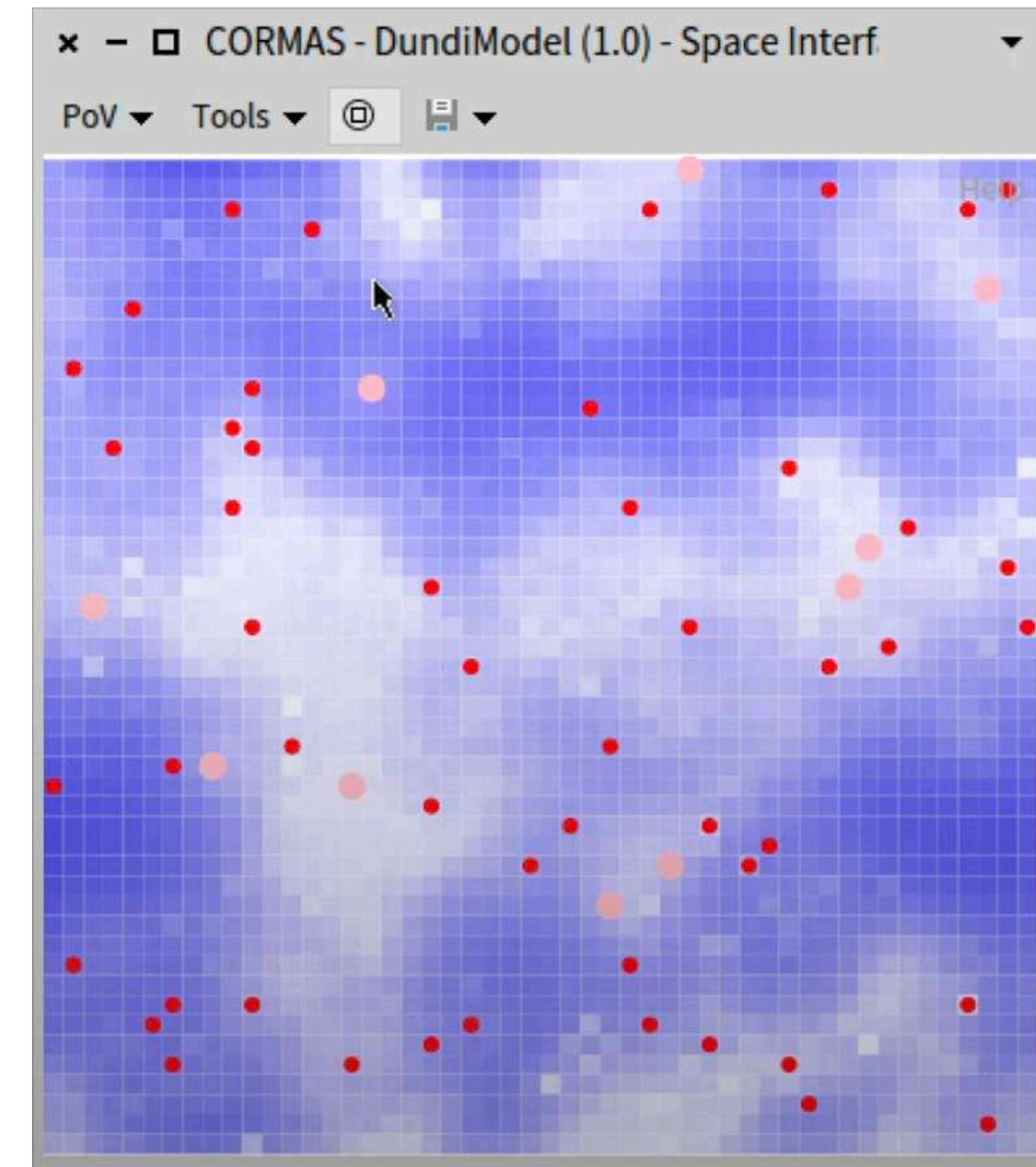
Different « Points of View »



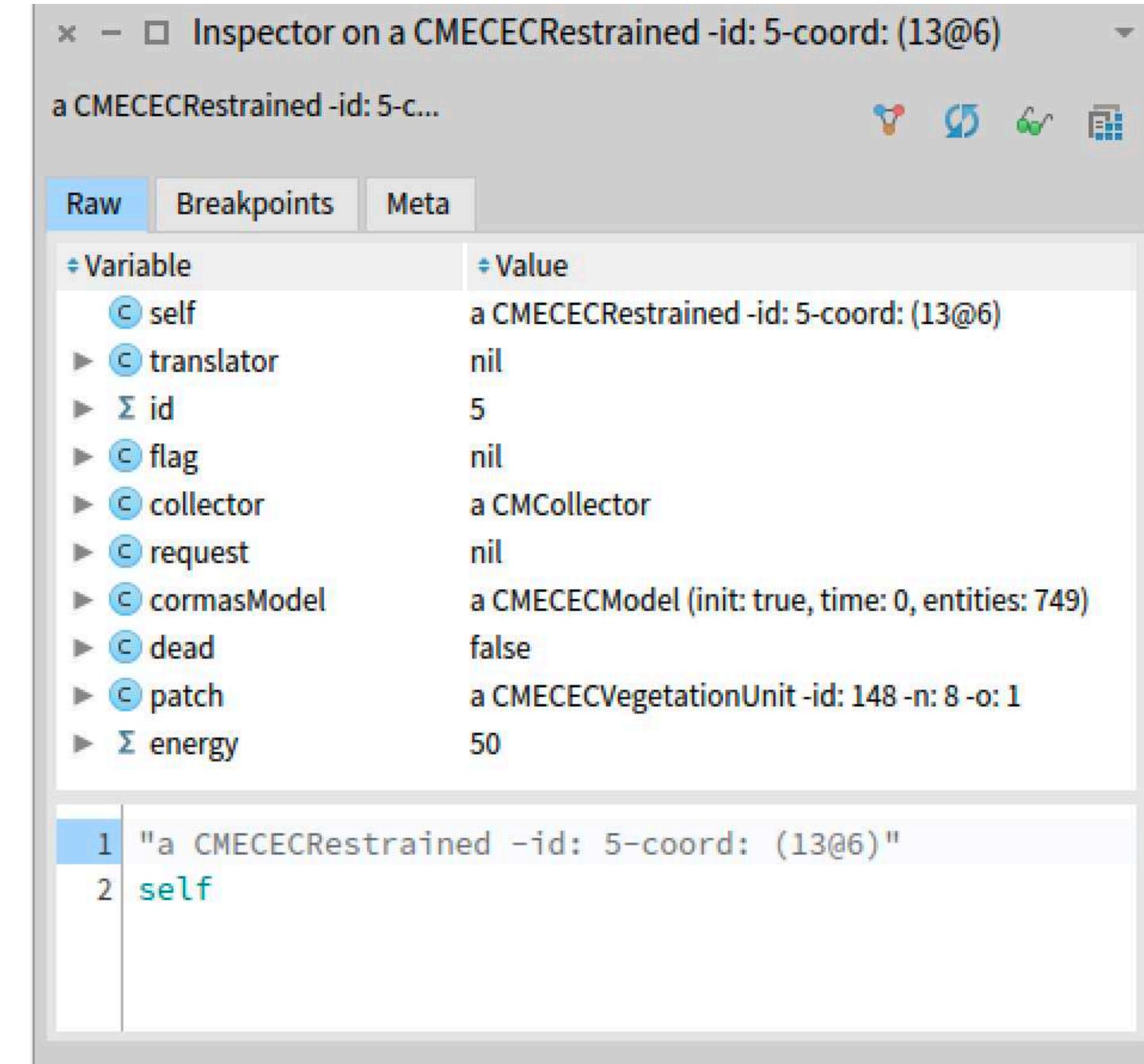
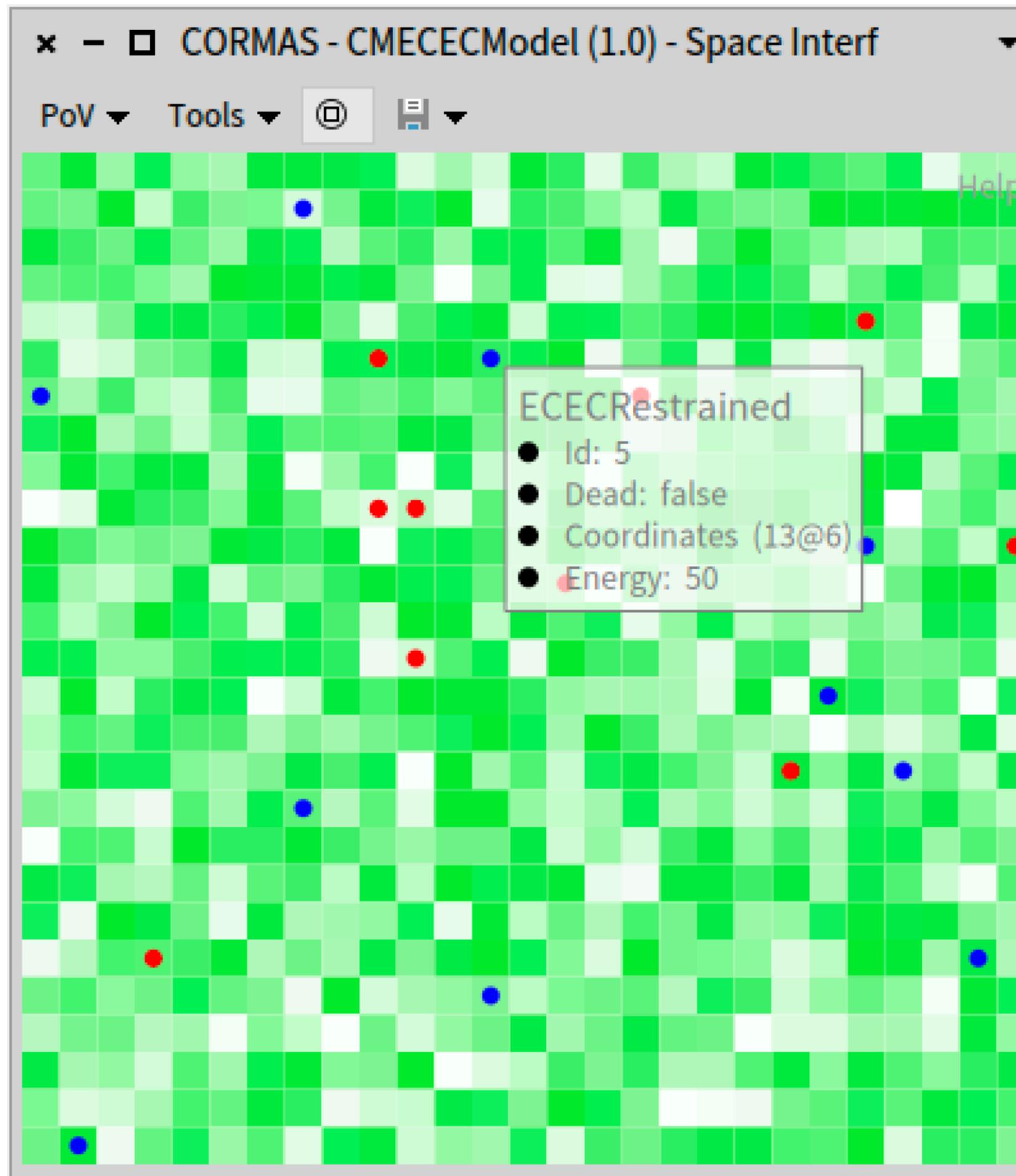
PoV 1: Grass



PoV 2: Water



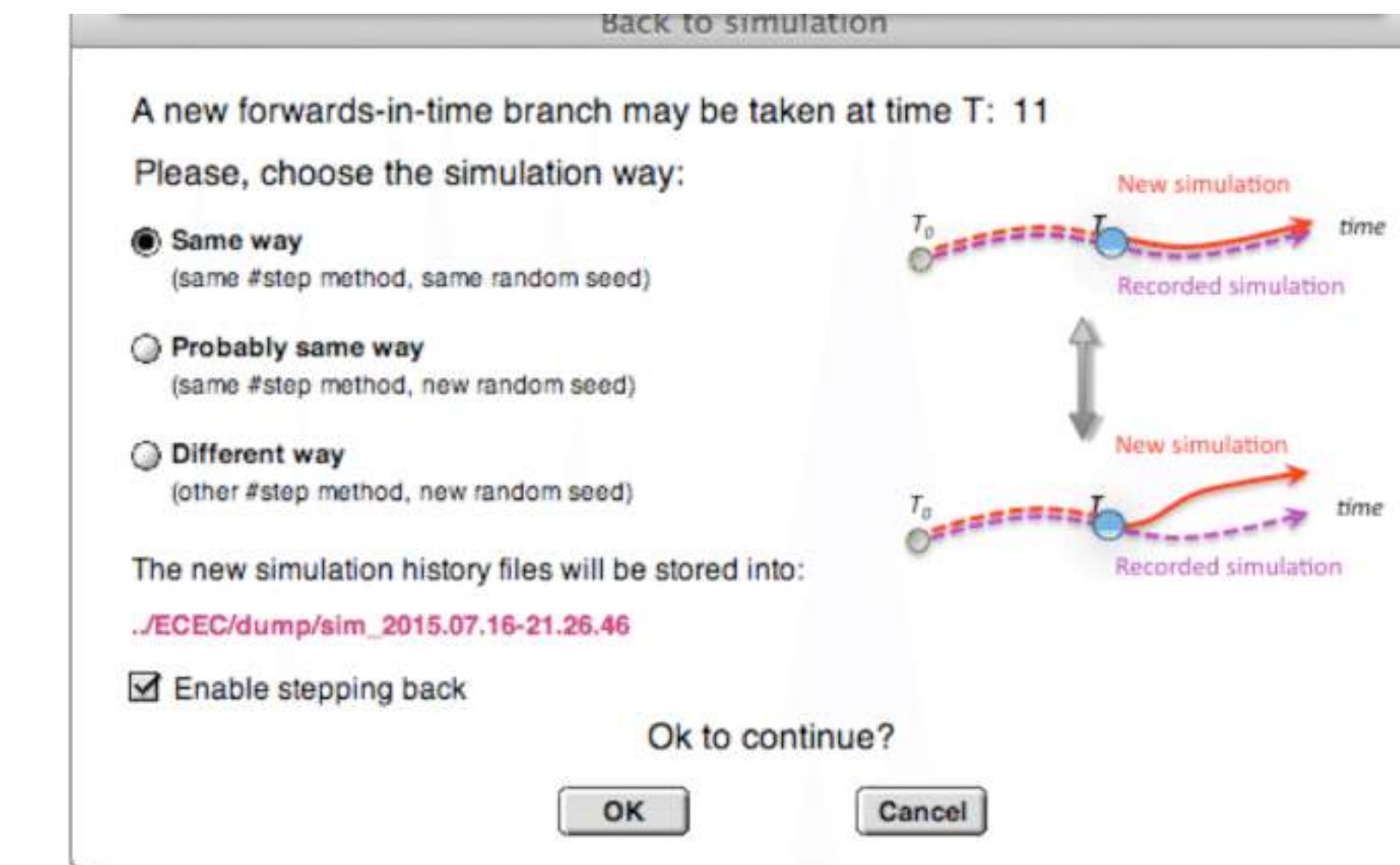
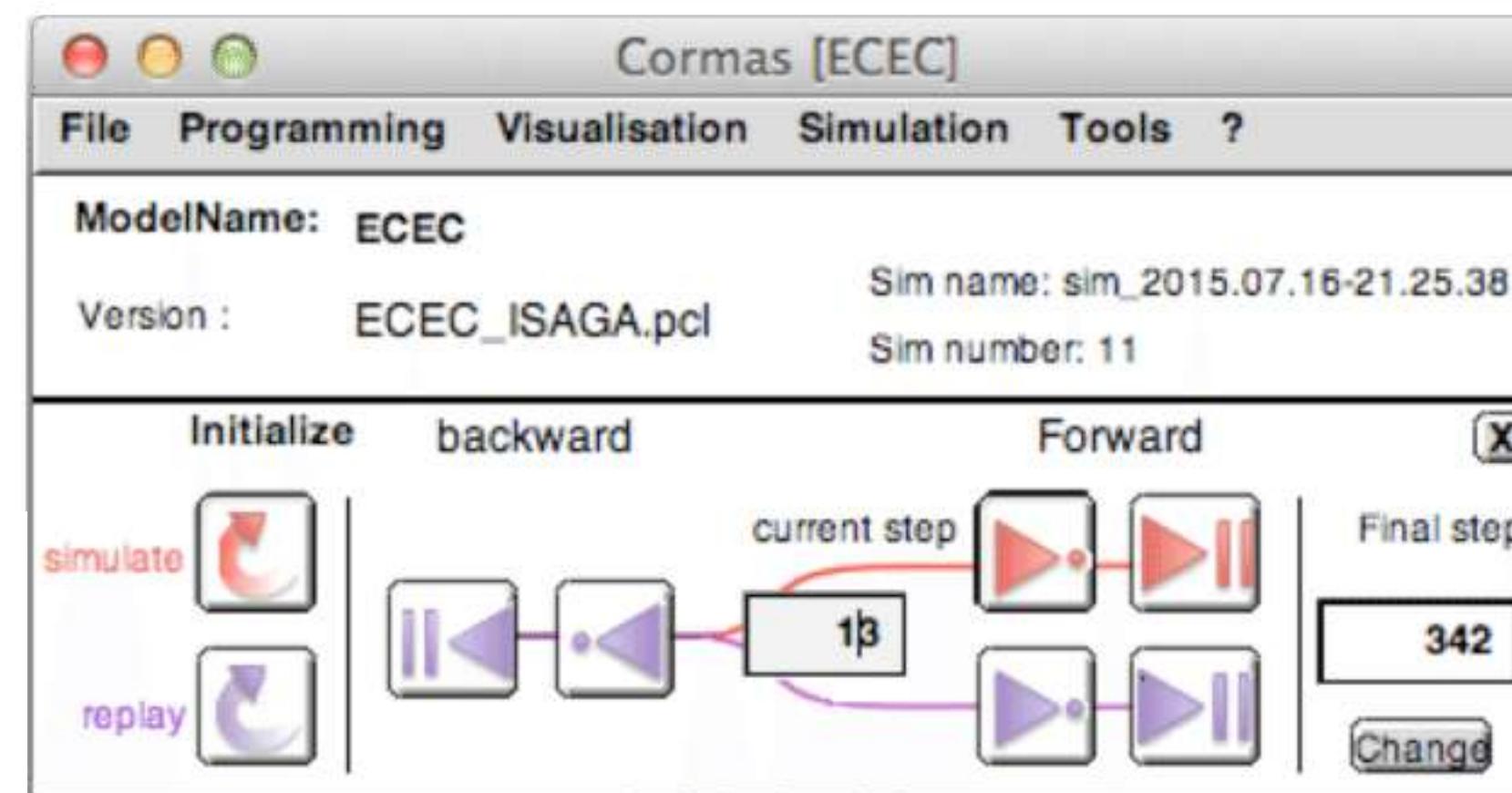
Inspect and Control Agents



Stepping Back in Time



Not yet supported in Pharo version

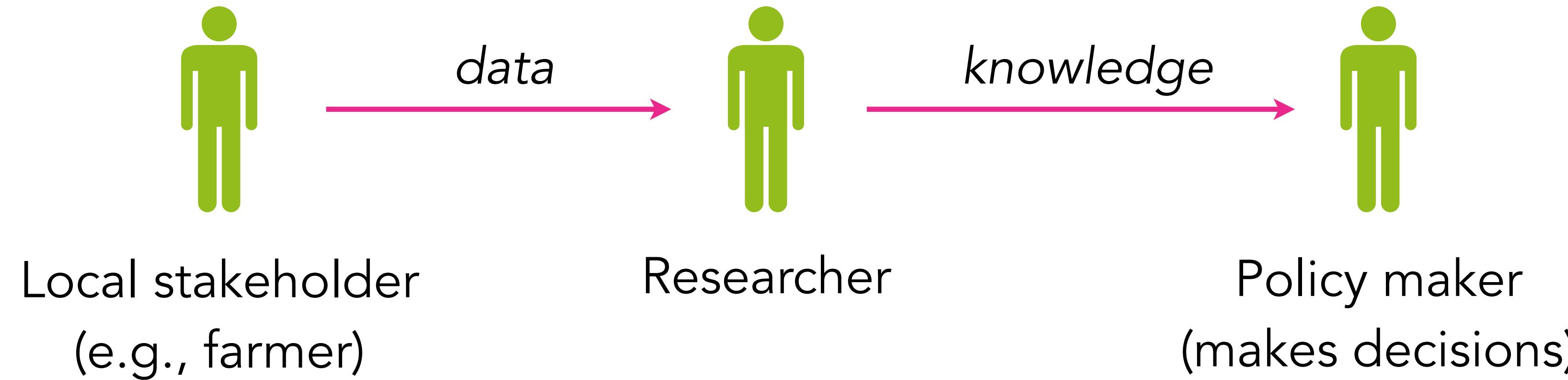




Part 3:

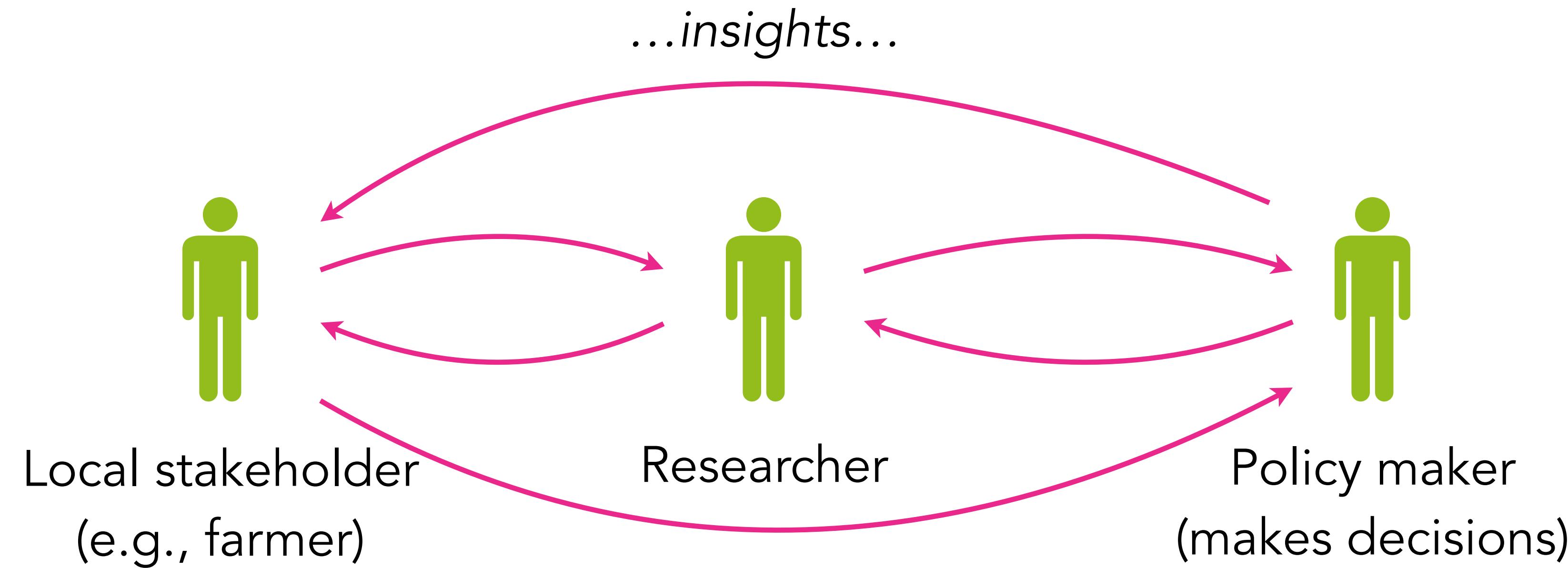
Research Directions

« Conventional » Modelling



Local stakeholders are only contacted for data collection

Participatory Modelling

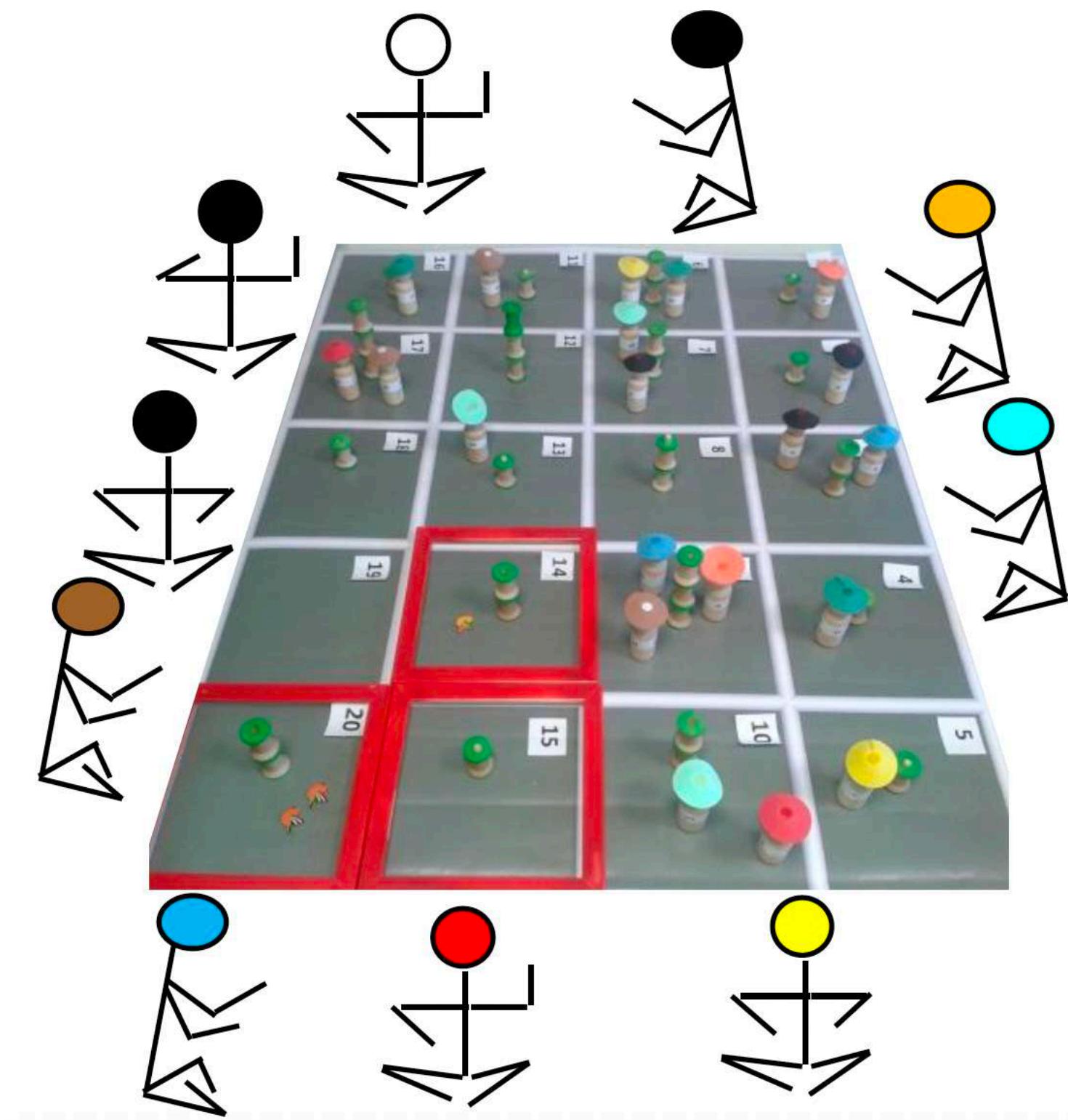


Local stakeholders are involved in every step of modelling: data collection, model building, model exploration

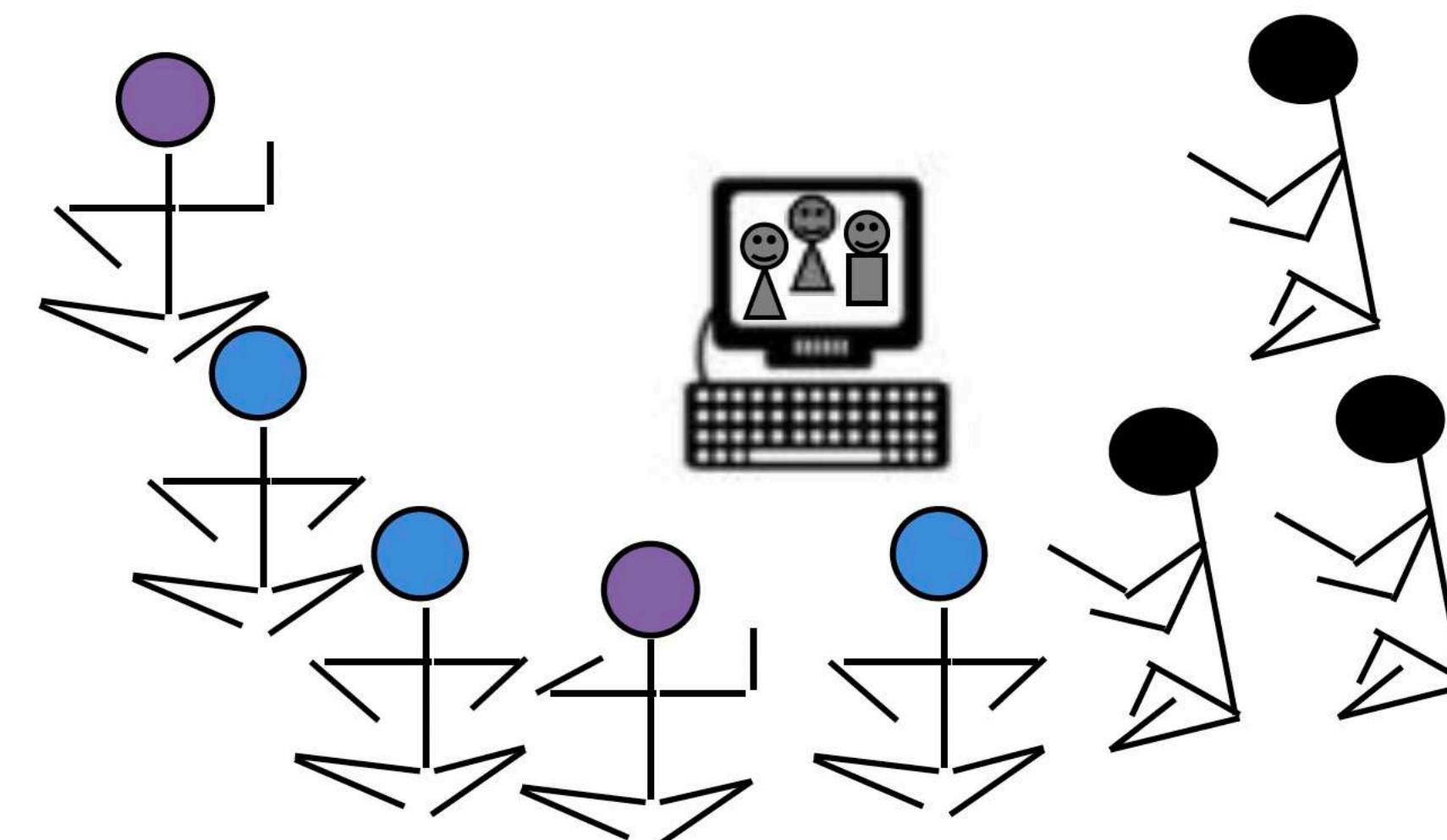
Our Two Activities at CIRAD



Role-Playing Games



Agent-Based Modelling



Role-Playing Games (no computers)



Pros:

- Accessible
- Personal
- Interactive

Cons:

- Slow
- Imprecise
- Analysed later

Agent-Based Modelling



Pros:

- Fast & Powerful
- Immediate analysis (statistical, visual)

Cons:

- Unaccessible (too technical)
- Impersonal (barrier between researcher and participants)

Hybrid Approach



Combine the
benefits of both

- People have real (tangible) interactions
- Computer observes and supports them

Computerization



One way to do it:

Use software, AI, and IoT to replace humans in cumbersome tasks

Another way:

Empower citizens to be the actors of their own social transformation.

Use software, AI, and IoT to build tools for effective communication, exploration, and knowledge sharing

Three Research Directions



Topic 1: Modelling Language

What is the language that would allow non-programmers to define models easily?

Topic 2: Tangible Interaction

Can we help stakeholders to build and control models through physical interaction?

Topic 3: Collaborative Modelling

Can multiple people interact with the same model simultaneously with different PoV?

Topic 1: Modelling Language



What is the language that would allow non-programmers to define models easily?

Problem:

Modelling involves programming.

Programming is difficult for non-programmers

*How hard would it be for geographer
or biologist to use an ABM platform
for the first time?*

Can we make it easier?

More intuitive?

A screenshot of the NetLogo software interface titled "NetLogo — Fire". The window has tabs for "Interface", "Info", and "Code". The "Code" tab is selected, showing a portion of the NetLogo code for a fire simulation. The code includes sections for "globals", "breed", "setup", "go", and "ignite". A specific line of code, "ask neighbors4 with [pcolor = green]", is highlighted with a yellow background. The code uses a mix of English comments and NetLogo commands like "clear-all", "set-default-shape", "ask", and "set".

```
globals [
    initial-trees ;; how many trees (green patches) we started with
    burned-trees ;; how many have burned so far
]

breed [fires fire] ;; bright red turtles -- the leading edge of the fire
breed [embers ember] ;; turtles gradually fading from red to near black

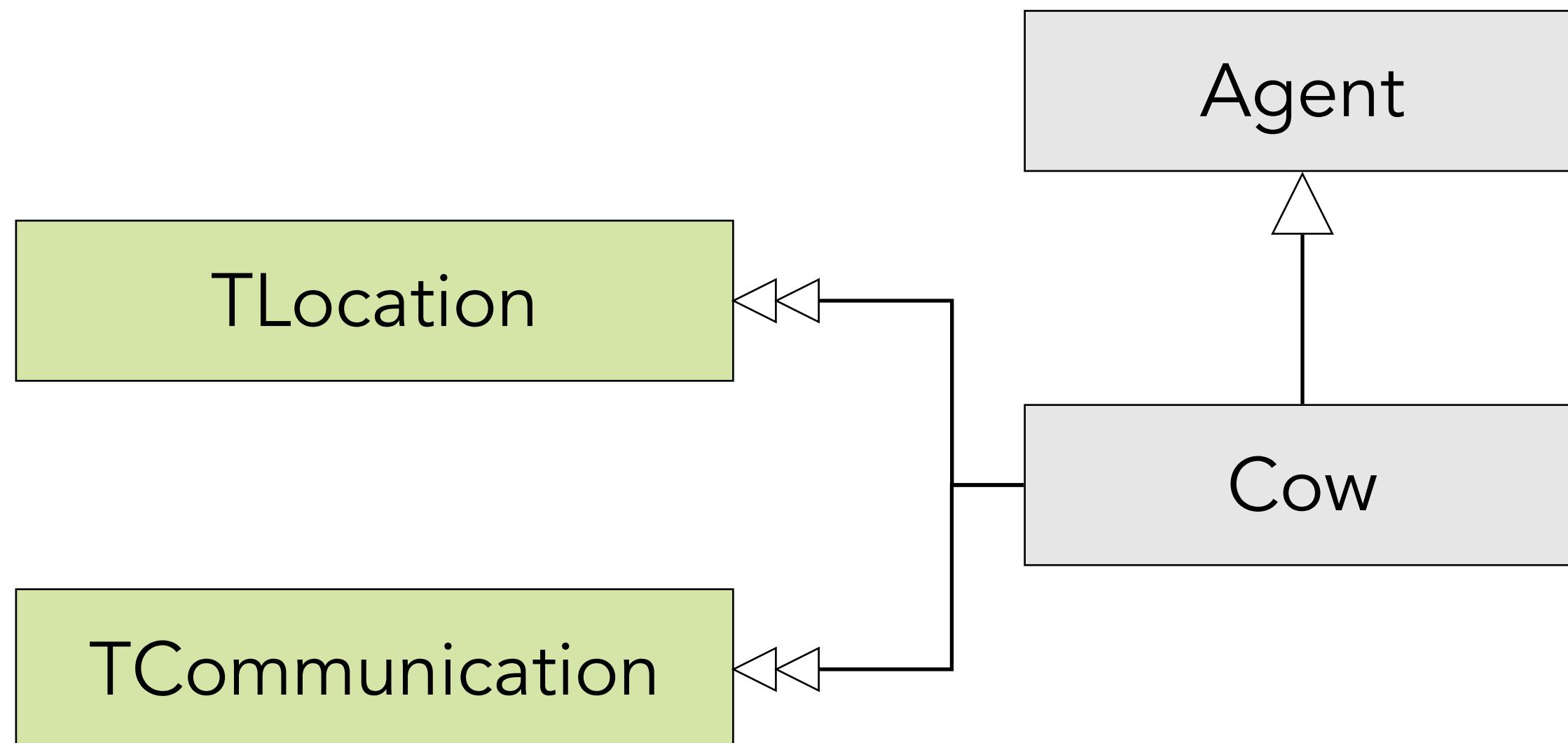
to setup
    clear-all
    set-default-shape turtles "square"
    ;; make some green trees
    ask patches with [(random-float 100) < density]
        [ set pcolor green ]
    ;; make a column of burning trees
    ask patches with [pxcor = min-pxcor]
        [ ignite ]
    ;; set tree counts
    set initial-trees count patches with [pcolor = green]
    set burned-trees 0
    reset-ticks
end

to go
    if not any? turtles ;; either fires or embers
        [ stop ]
    ask fires
        | [ ask neighbors4 with [pcolor = green]
            [ ignite ]
            set breed embers ]
        fade-embers
        tick
    end

    ;; creates the fire turtles
    to ignite ;; patch procedure
        sprout-fires 1
        [ set color red ]
        set pcolor black
        set burned-trees burned-trees + 1
    end
```

Topic 1: Modelling Language

What is the language that would allow non-programmers to define models easily?

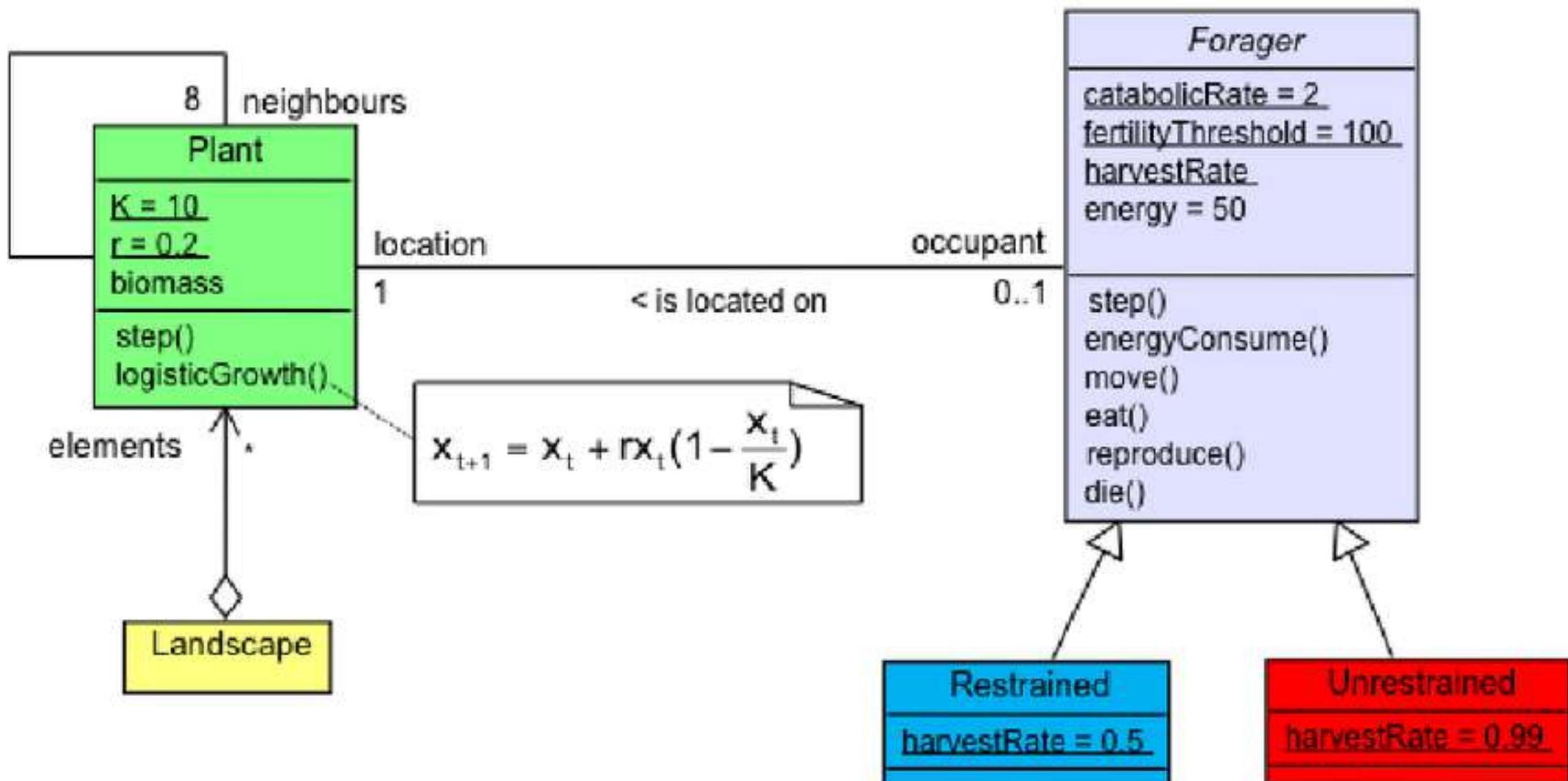


Solution 1: Object-oriented ABM

- Intuitive OOP framework
- Traits - composable units of behaviour
- Model testing framework

Topic 1: Modelling Language

What is the language that would allow non-programmers to define models easily?



Solution 2: Executable diagrams

- ARDI / PARDI diagrams
- UML class diagrams
- UML activity diagrams

Topic 2: Tangible Interaction

Can we help stakeholders to build and control models through physical interaction?

Problem:

During the participatory sessions in the field, it is often difficult to put every participant in front of a computer and make them manipulate the model.

- ⚡ Access to electricity
- 💻 Access to computers
- 📚 Computer literacy

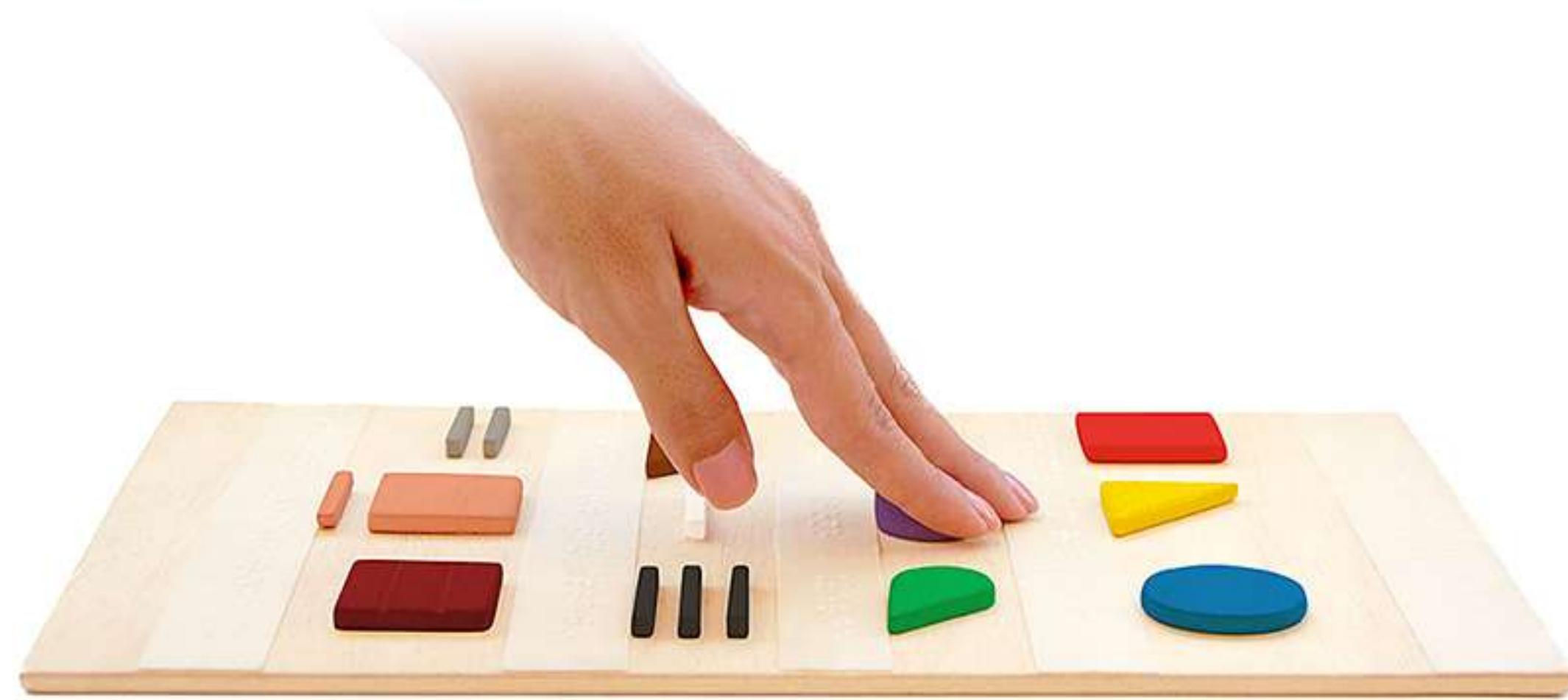


Caroline Dangleant

Caroline Dangleant © Cirad

Topic 2: Tangible Interaction

Can we help stakeholders to build and control models through physical interaction?



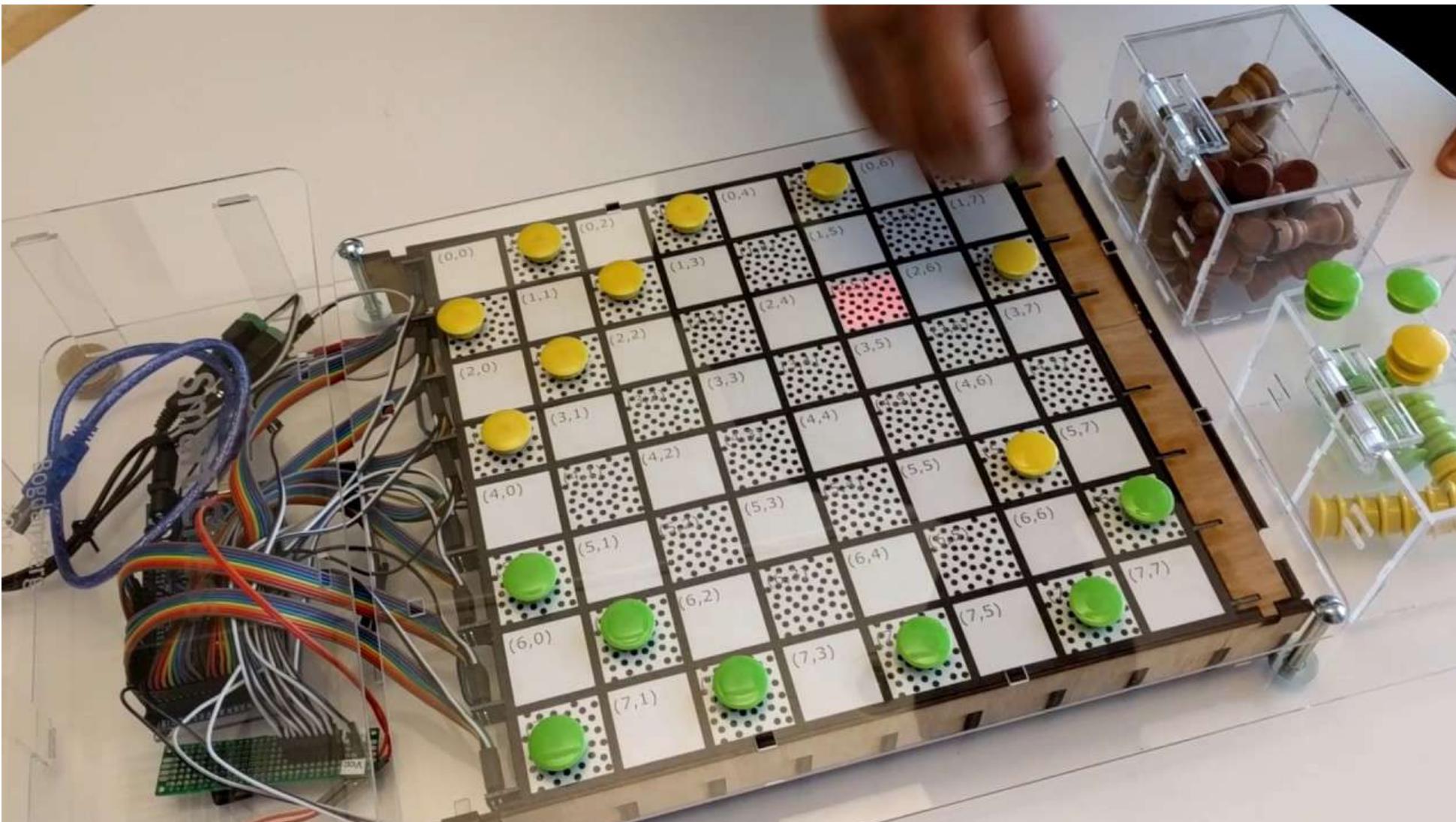
Hypothesis:

We communicate ideas better when they are tangible.
Touching something is better than seeing it on a screen

Topic 2: Tangible Interaction

Can we help stakeholders to build and control models through physical interaction?

Solution 1: Sensory game board



- Game board can detect the position of pieces using sensors
- Implement using Raspberry Pi or Arduino and PharoThings library



Mouhamadou Falilou BALL

Intern at CIRAD
from UMISSCO, Senegal

Topic 2: Tangible Interaction



Can we help stakeholders to build and control models through physical interaction?



Solution 2: Computer vision

- AI algorithm that detects game pieces on a table
- Can be paired with simulation projection that was done with Cormas (ReHab?)

Christophe LePage © Cirad

Topic 2: Tangible Interaction



Can we help stakeholders to build and control models through physical interaction?



Solution 3: Augmented reality

Interactive modelling experience with **virtual reality** (full immersion) or **augmented reality** (enhance real world with computer-generated perceptual information)



Topic 3: Collaborative Modelling



Can multiple people *interact with the same model simultaneously with different PoV?*

Problem: Farmers think about crops, pastoralists think about cows.
How can we help them understand each other and collaborate?

Farmer



Thierry Brevault © Cirad

Pastoralist



Patrick Dugue © Cirad

Fisherman



Eric Malezieux © Cirad

Policy maker



I. Duriez © Cirad

Topic 3: Collaborative Modelling



Can multiple people *interact with the same model simultaneously with different PoV?*

Solution: One model — many devices.

Different « point of view » and different set of controls
for each participant



- 🌾 Farmer controls the growth of crops.
- 🐄 Pastoralist manages the behaviour of kettle.
- 🐟 Fisherman observes the amount of fish in the river.
- 💰 Policy maker calculates the expenses.



... modelling for citizens by citizens

Modelling environment that is inclusive and takes into account the nature of its target communities, adapts to their particular needs and helps them overcome their limitations

Modelling Language

- Object-oriented modelling
- Executable diagrams

Tangible Interaction

- Sensory game board
- Computer vision
- Augmented reality

Collaborative Modelling

- One model — many devices
- Multiple « points of view »