ESUG — August 2023

Agent-Based Modelling in Pharo Using Cormas

Oleksandr ZAITSEV

CIRAD, UMR SENS, MUSE, Université de Montpellier, France

oleksandr.zaitsev@cirad.fr

cirad

sens
savoirs environnement sociétés

MUSE
MONTPELLIER UNIVERSITÉ D'EXCELLENCE

UNIVERSITÉ MONTPELLIER

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?

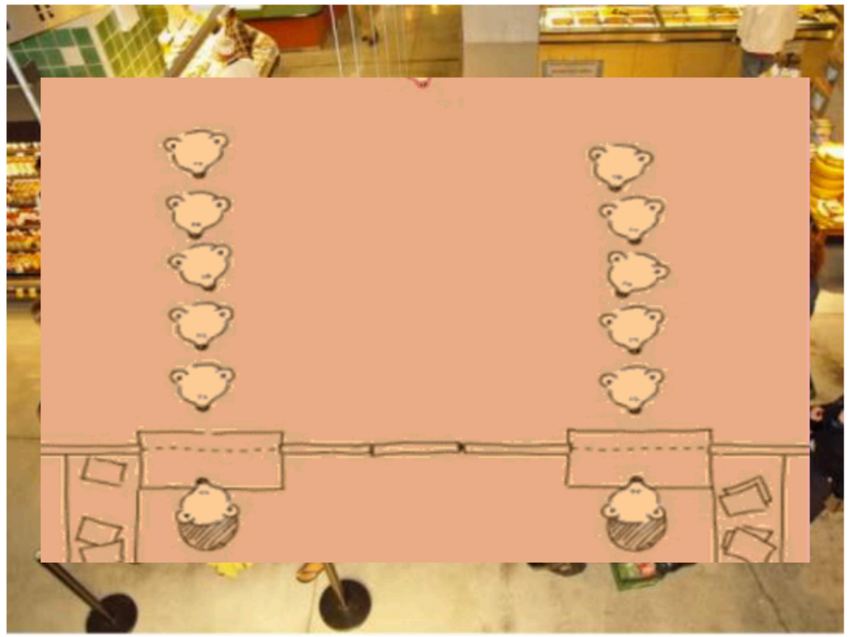
Q2: How do those patters of behavior then feed back to affect those individuals?

Some Applications

Which Queue to Choose?

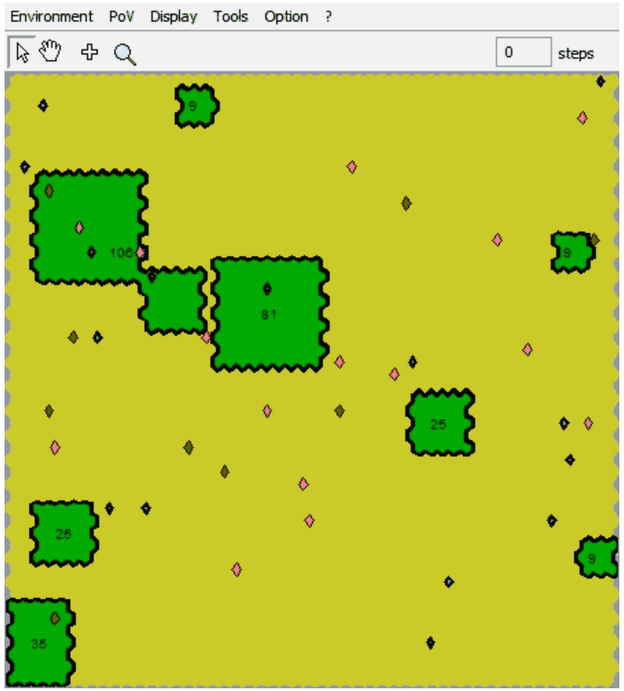
Real world

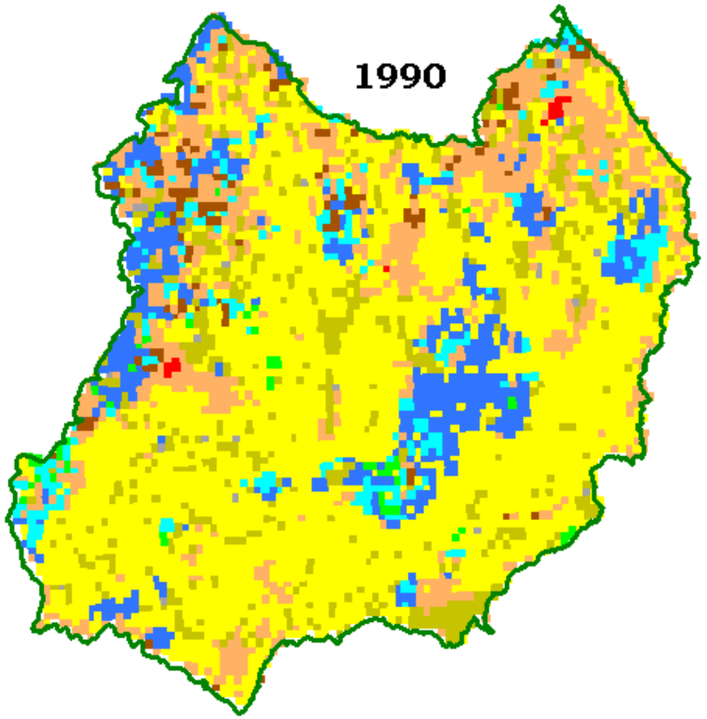
Model

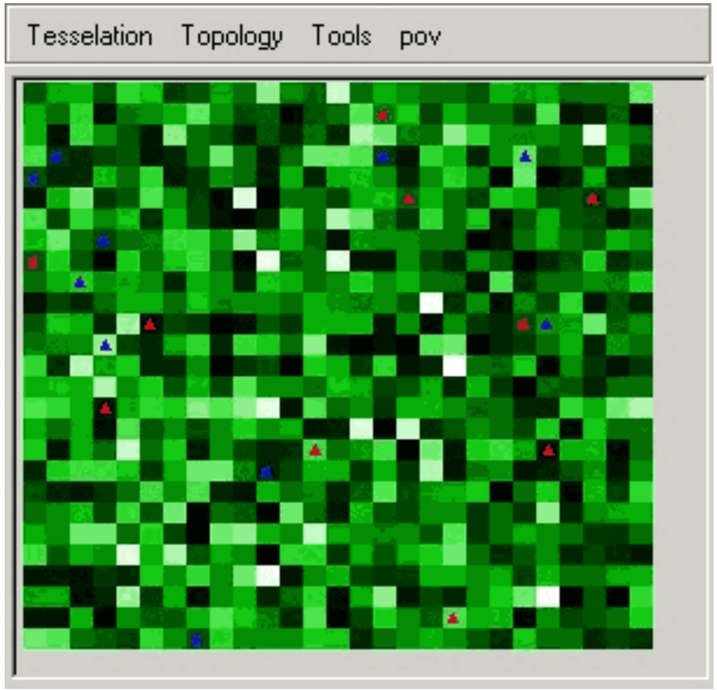


Your Own Little Lab

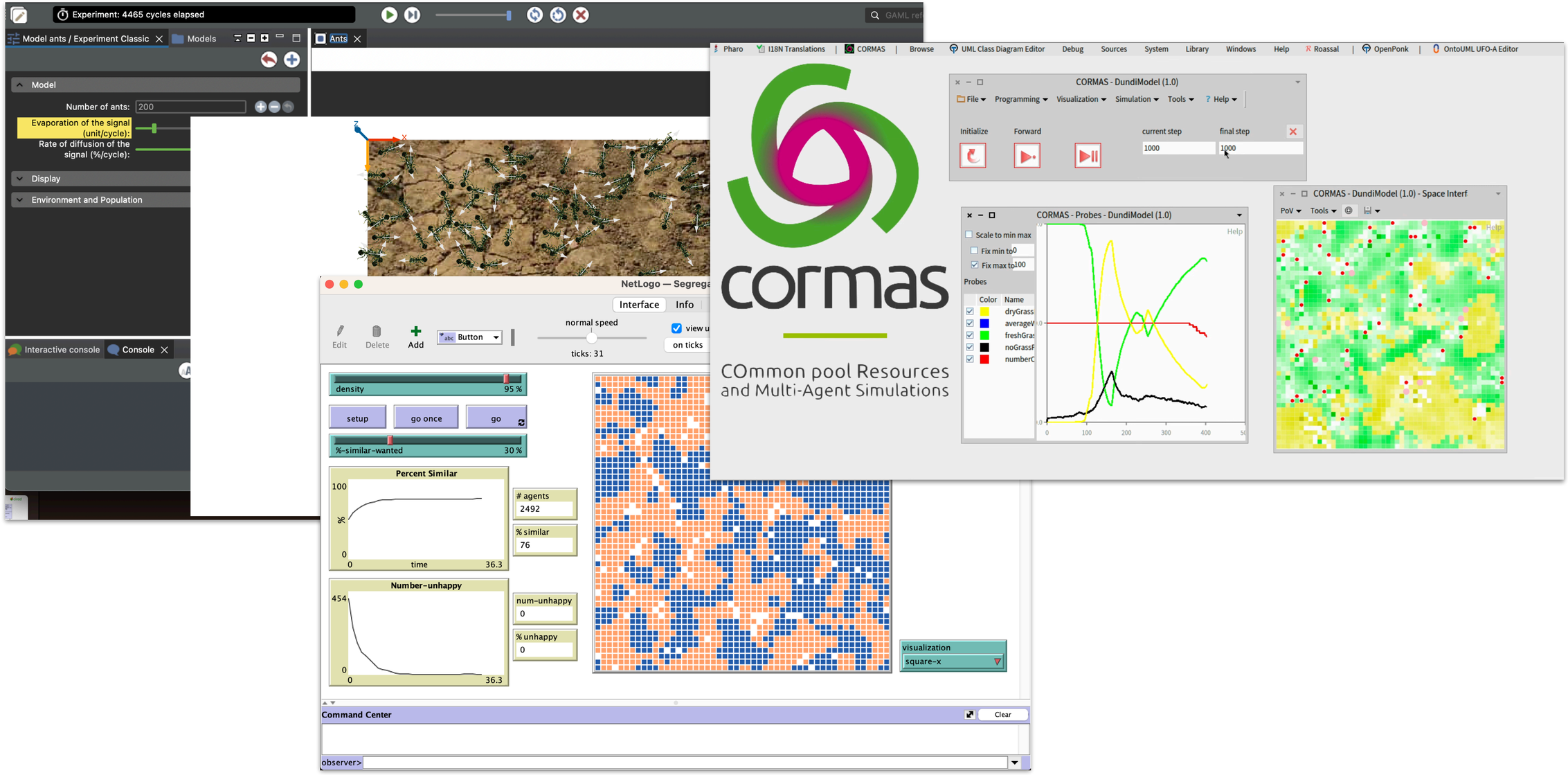
Test theories, explore interactions …







ABM Platforms



Part 2:
Cormas Platform

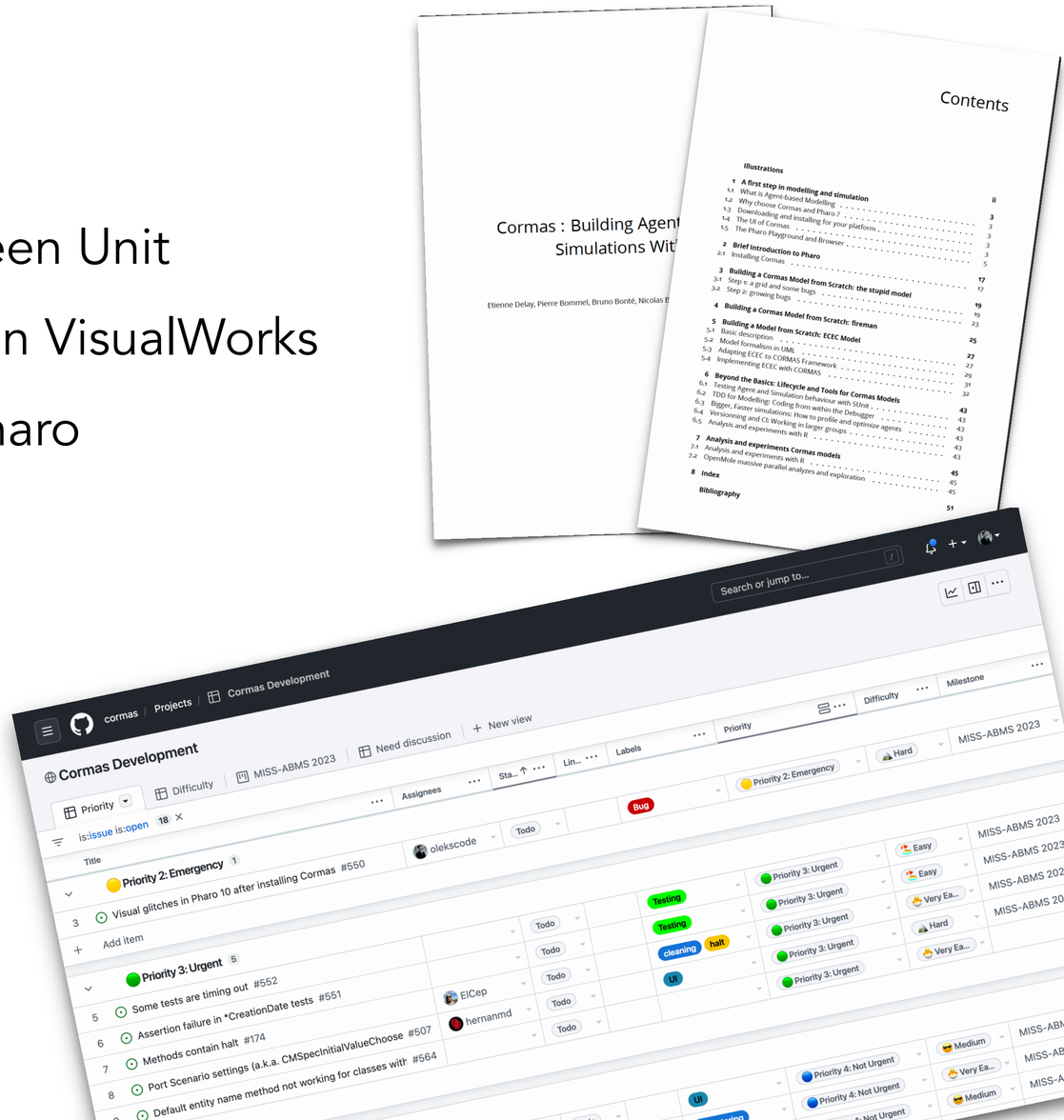
Cormas Platform

cirad

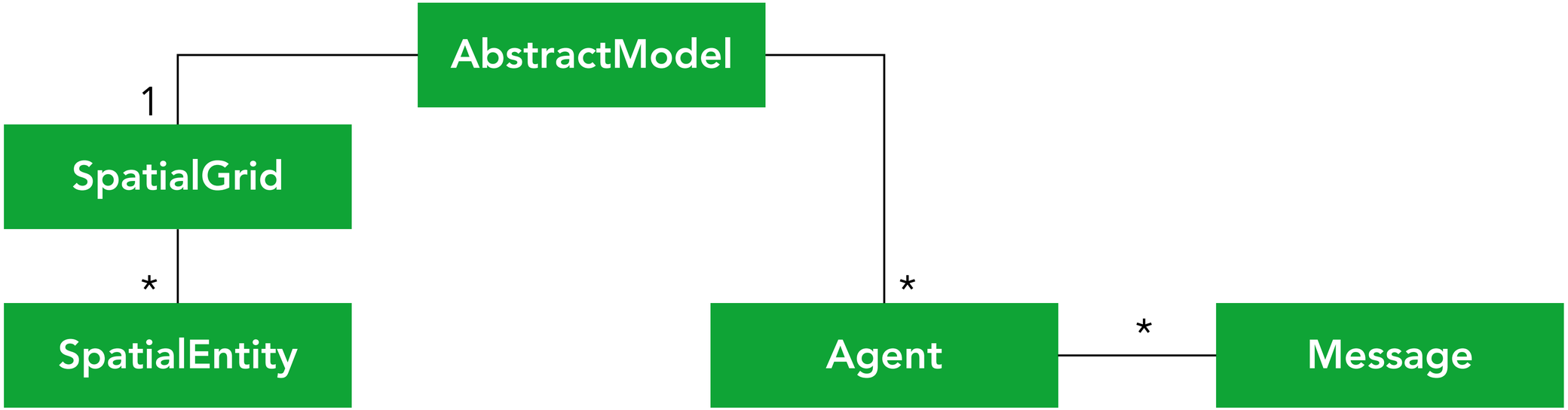
cormas

COmmon pool Resources and Multi-Agent Simulations

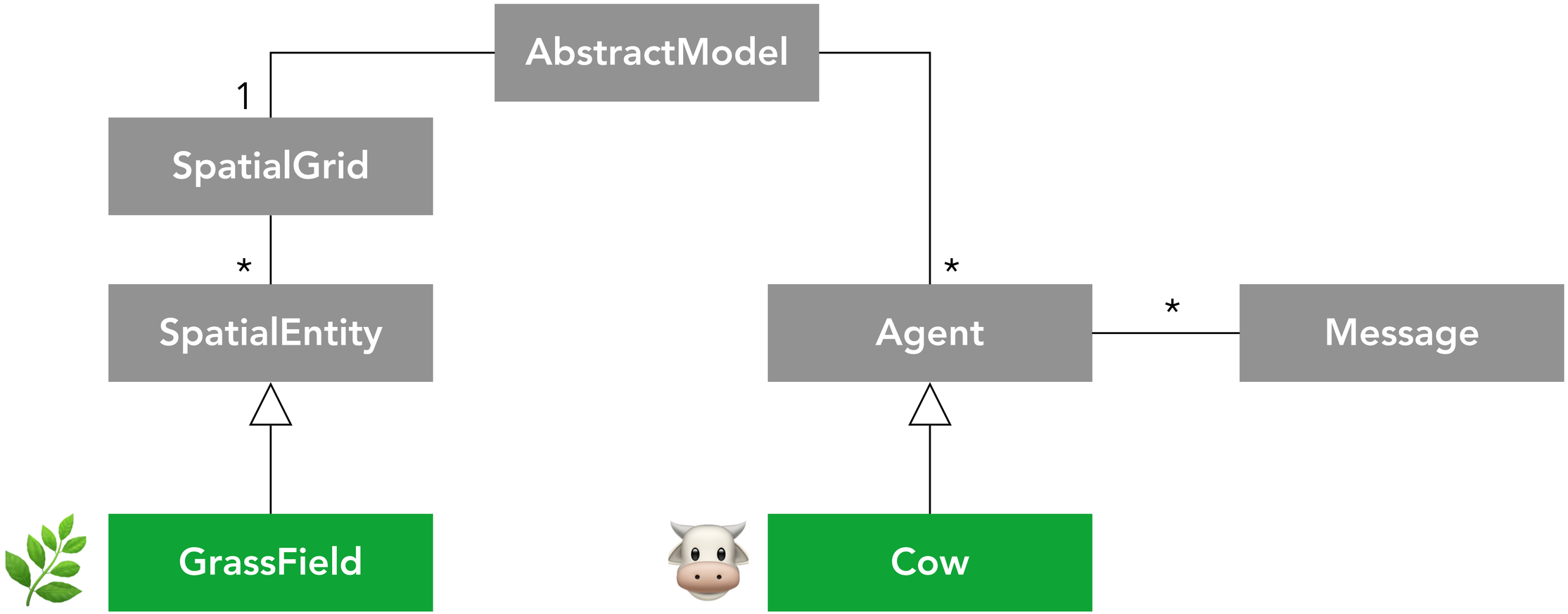
- ✓ Multi-agent simulations
- ✓ Developed in 90s by Green Unit
- ✓ Originally implemented in VisualWorks
- ✓ Ongoing migration to Pharo



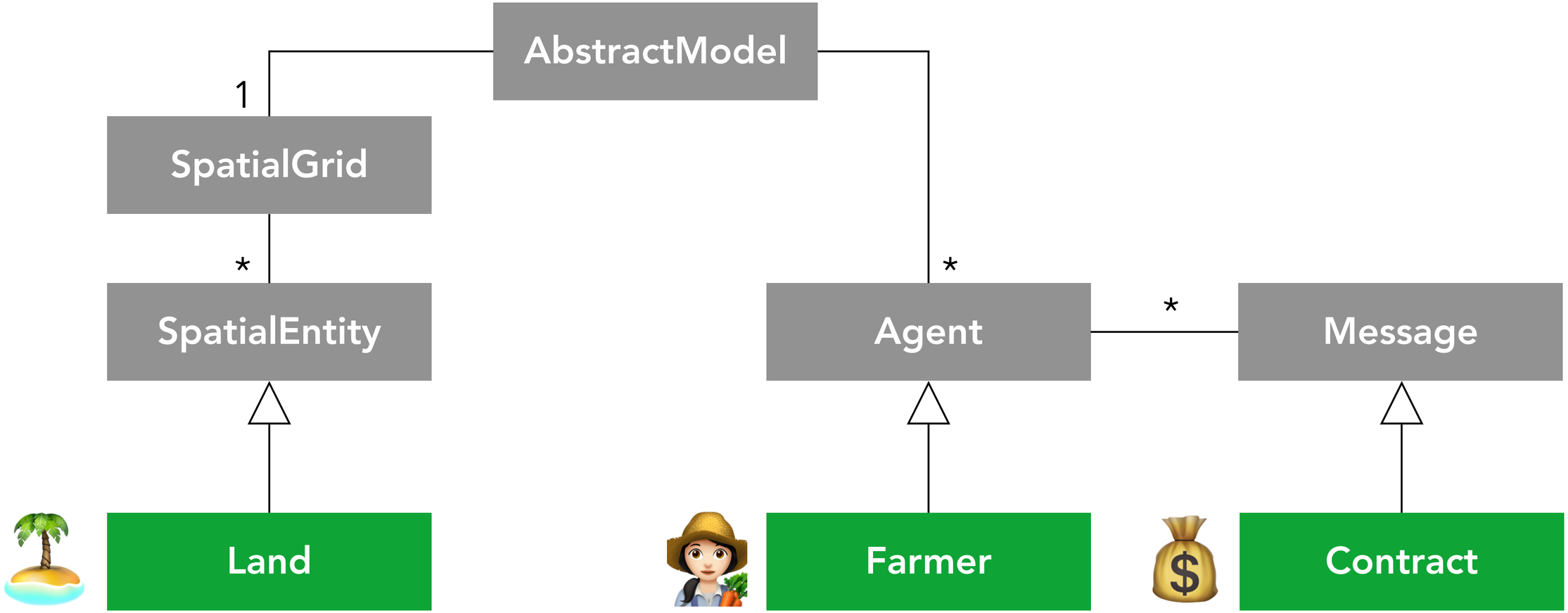
Basic Classes



Located Agents



Communicating Agents



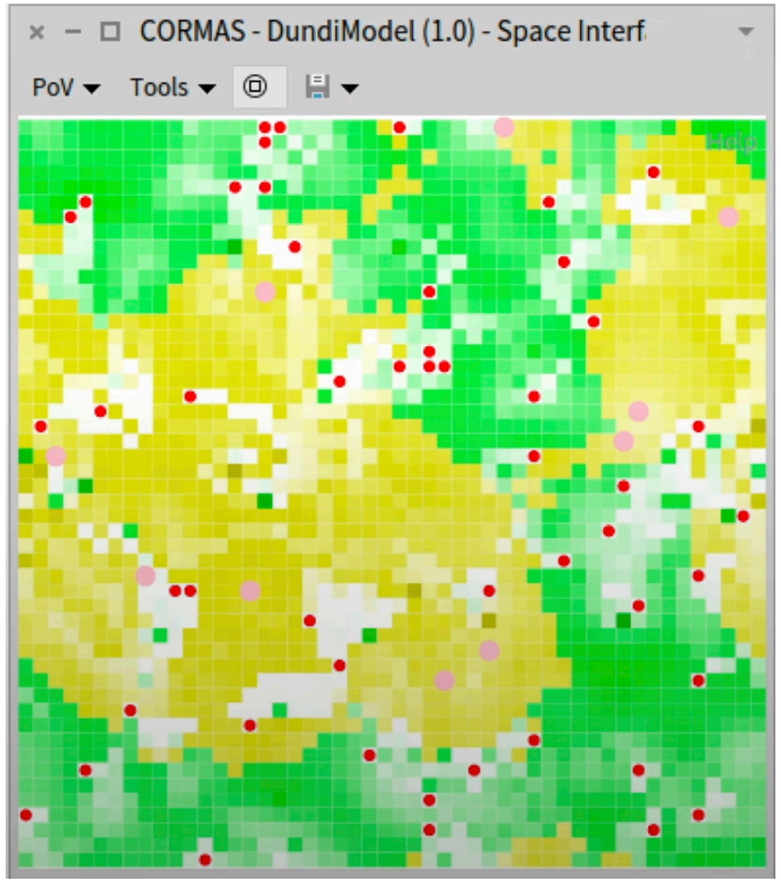
What Makes Cormas Unique?

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

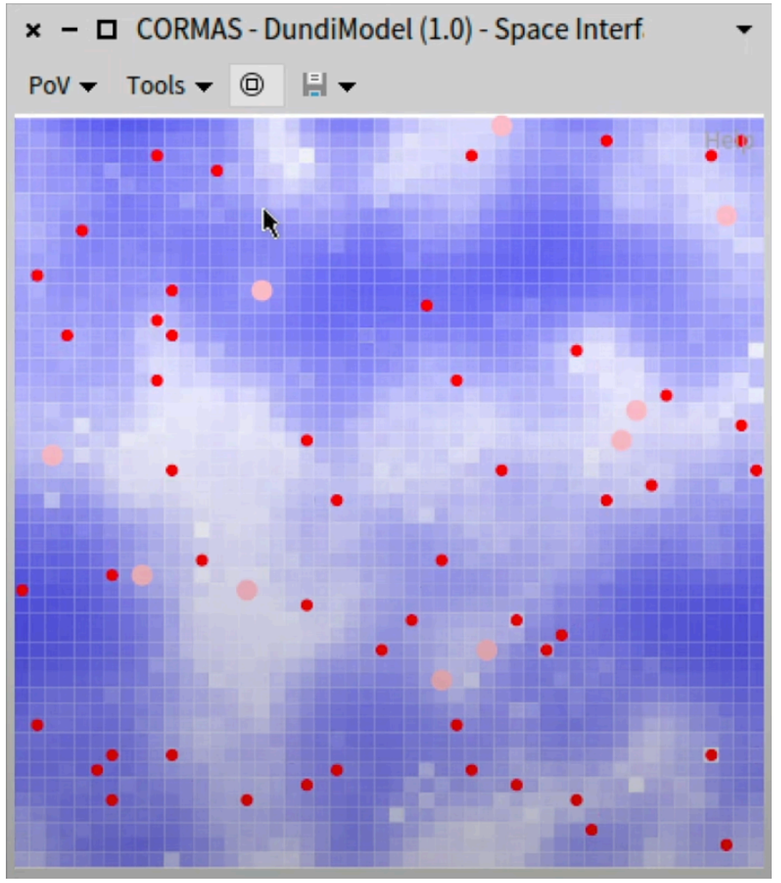
It provides different « points of view », allows users to inspect and control specific agents, allows stepping back in time.

Different « Points of View »

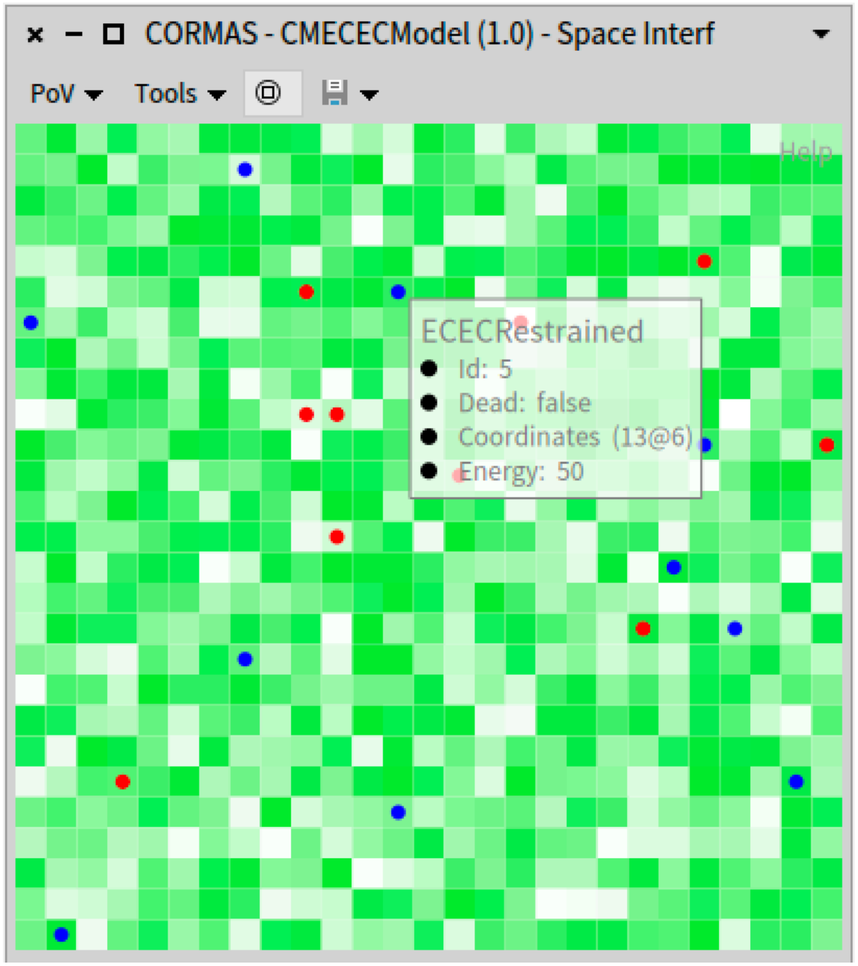
PoV 1: Grass

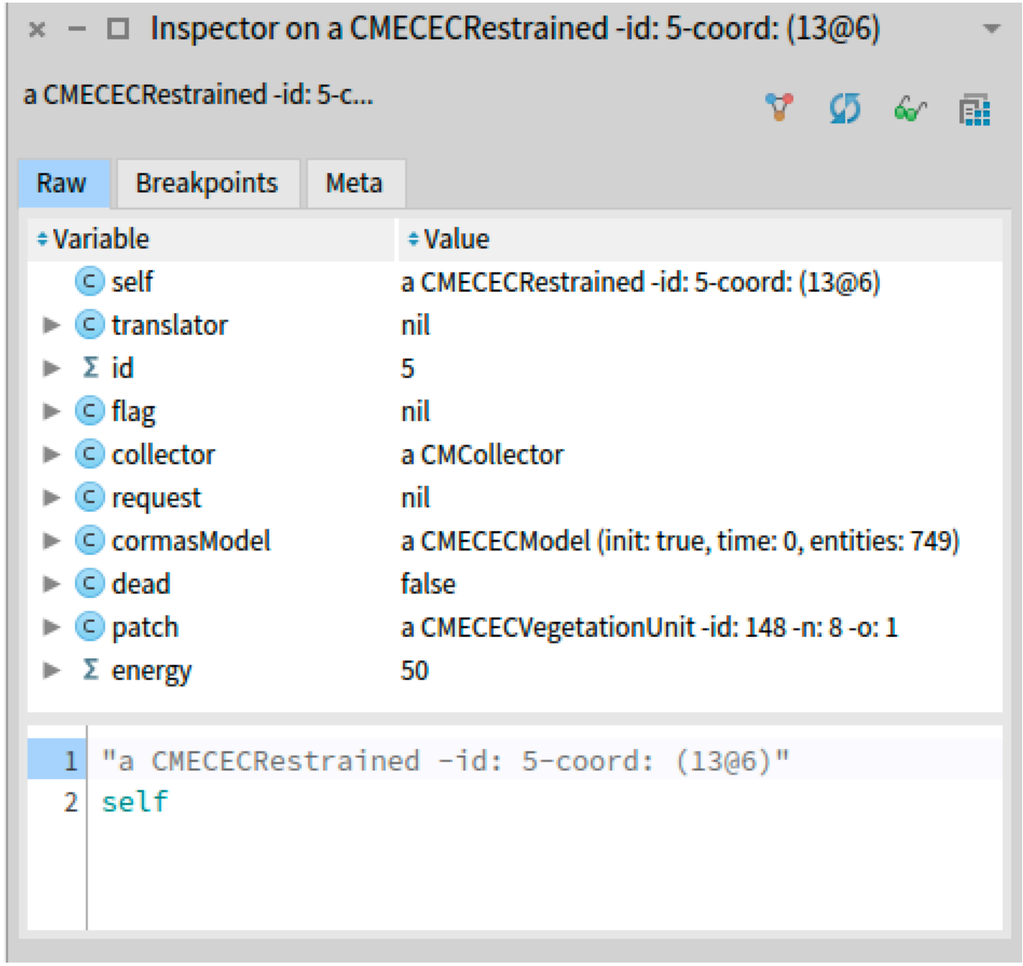


PoV 2: Water



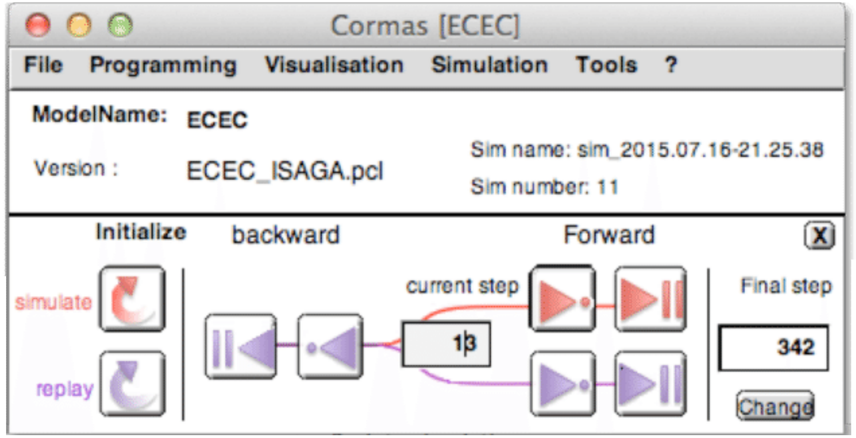
Inspect and Control Agents

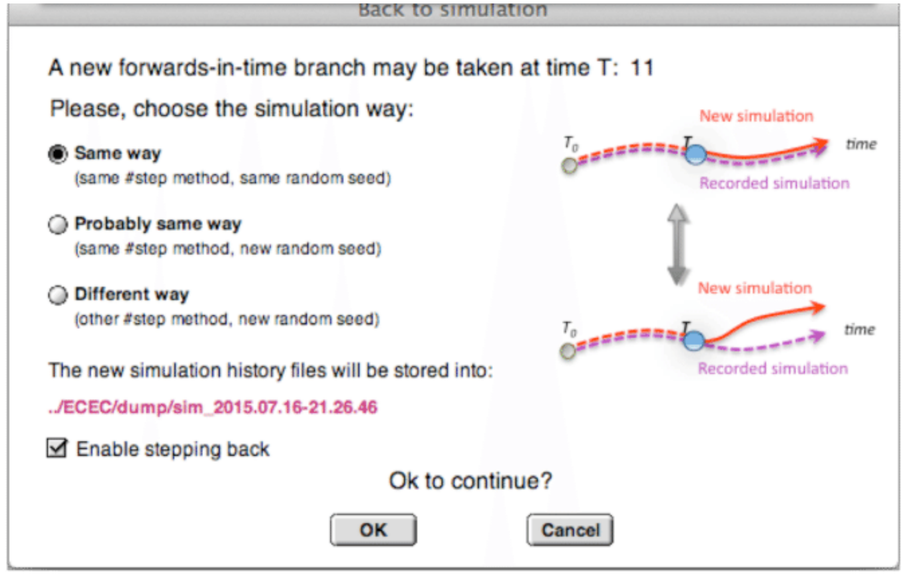




Stepping Back in Time

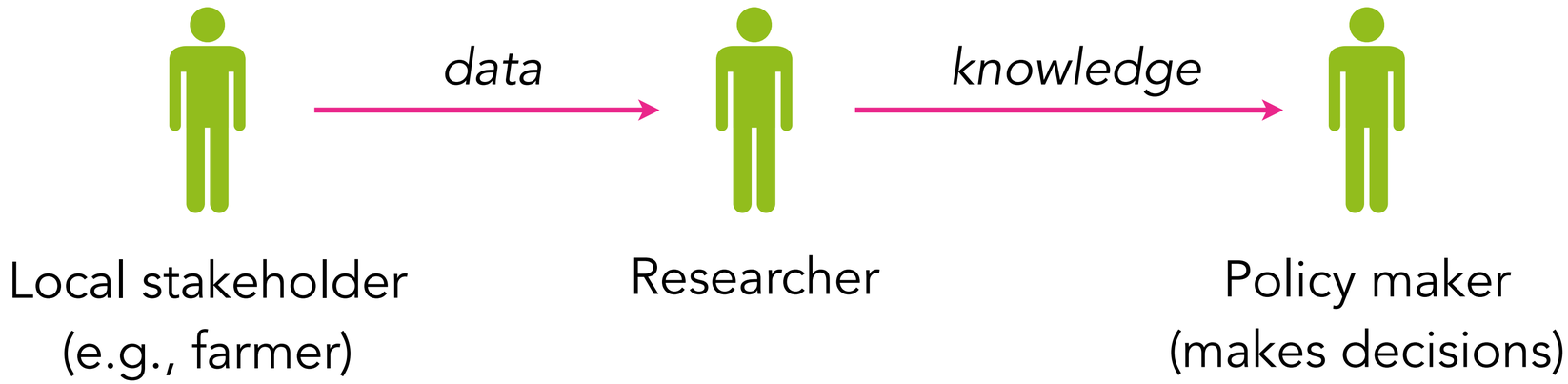
Not yet supported in Pharo version





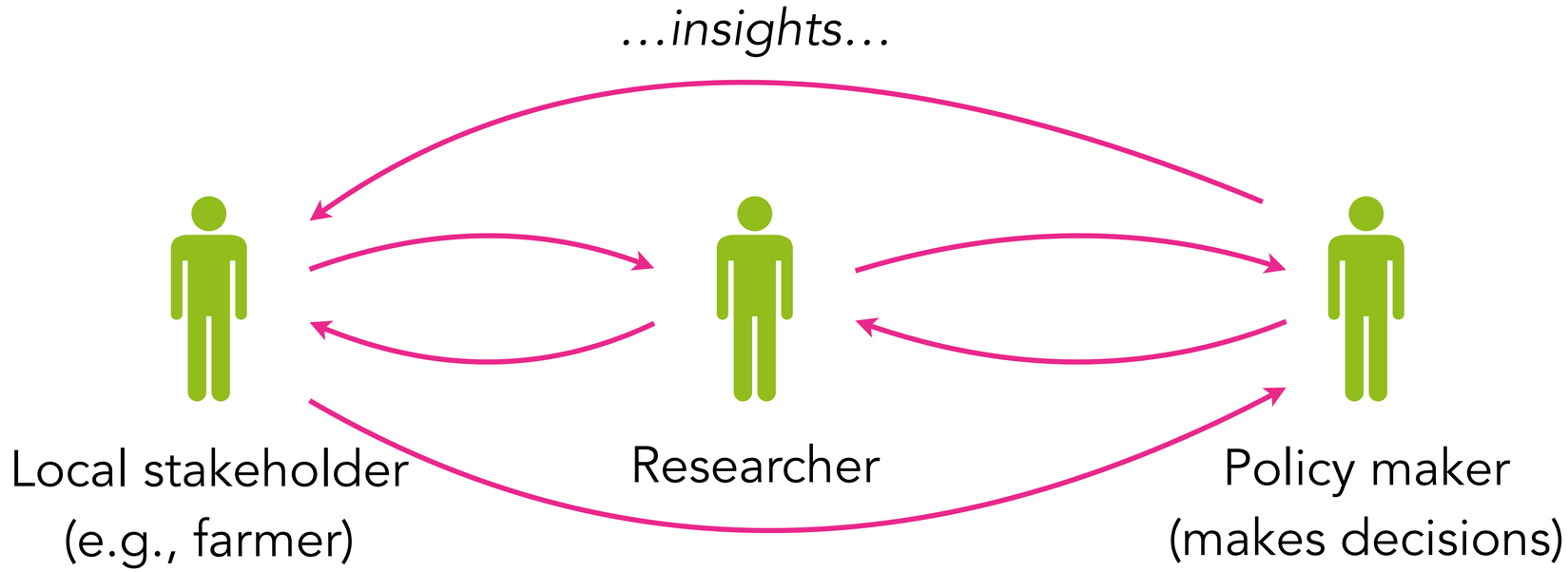
Part 3:
Research Directions

« Conventional » Modelling



Local stakeholders are only contacted for data collection

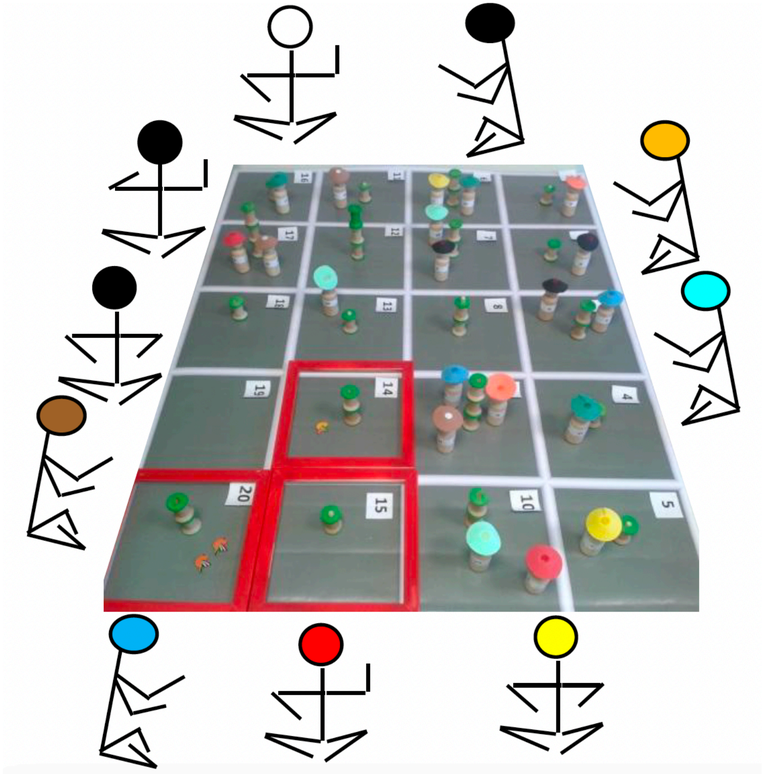
Participatory Modelling



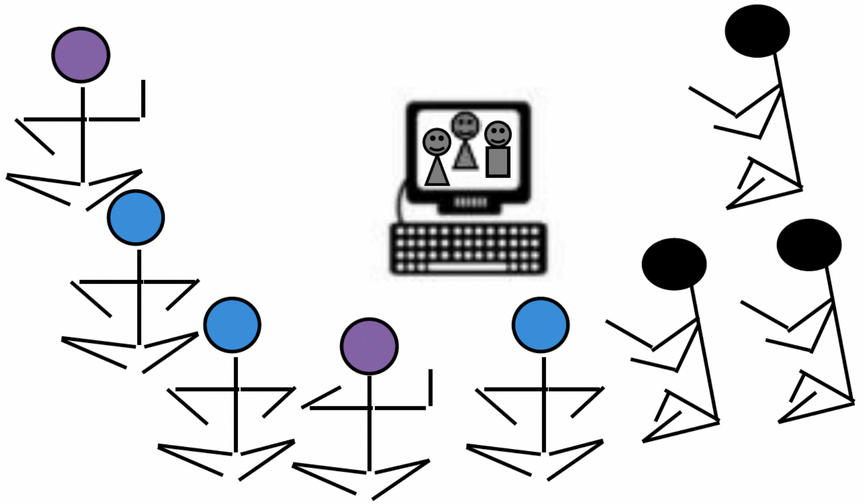
Local stakeholders are involved in every step of modelling: data collection, model building, model exploration

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

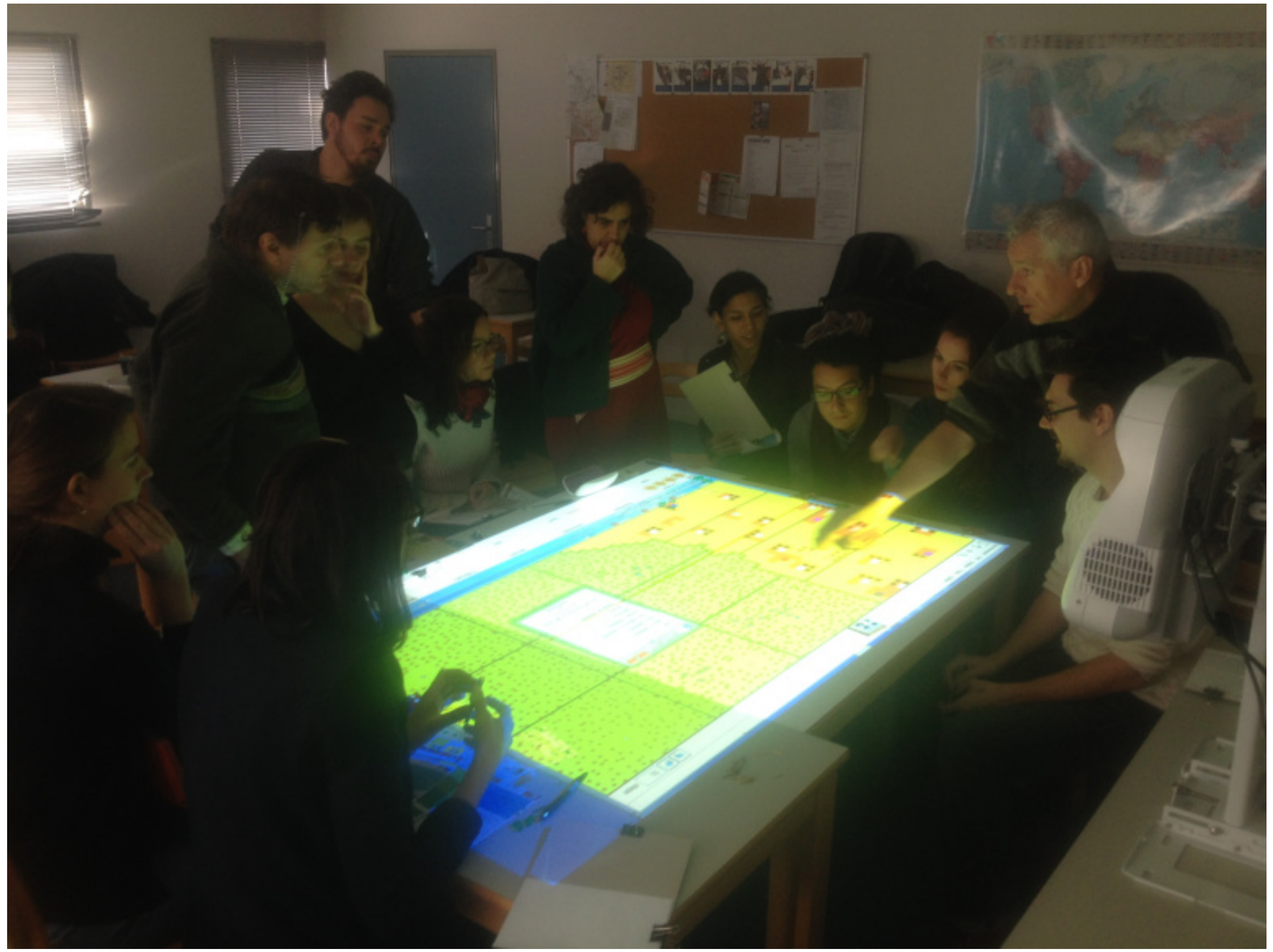
Pros:

- 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

cirad

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

cirad

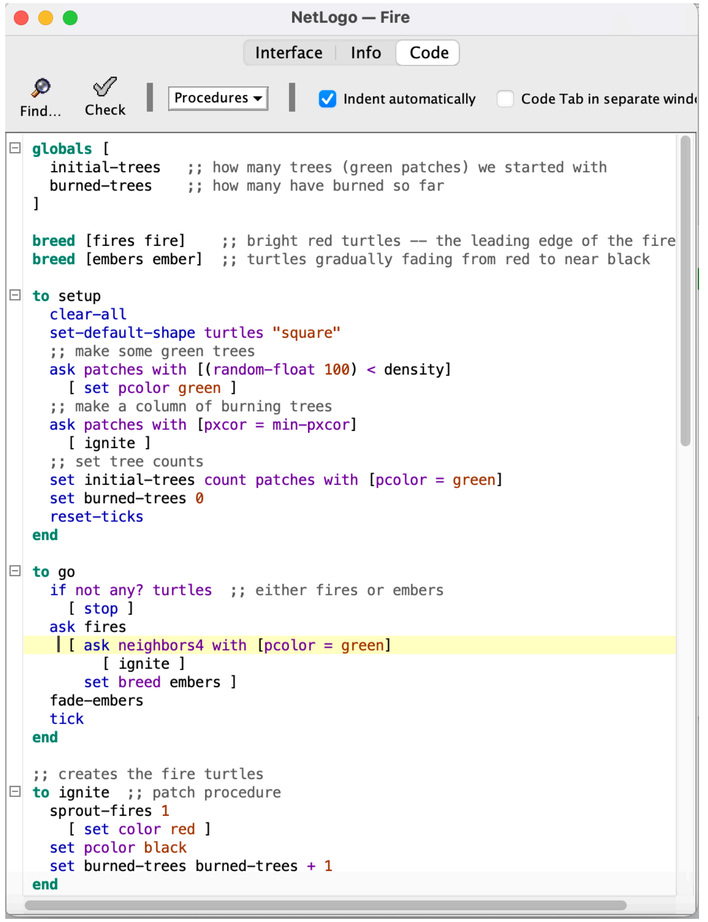
What is the language that would allow non-programmers to define models easily?

Problem:

Modelling involves programming.
Programming is difficult for non-programmers

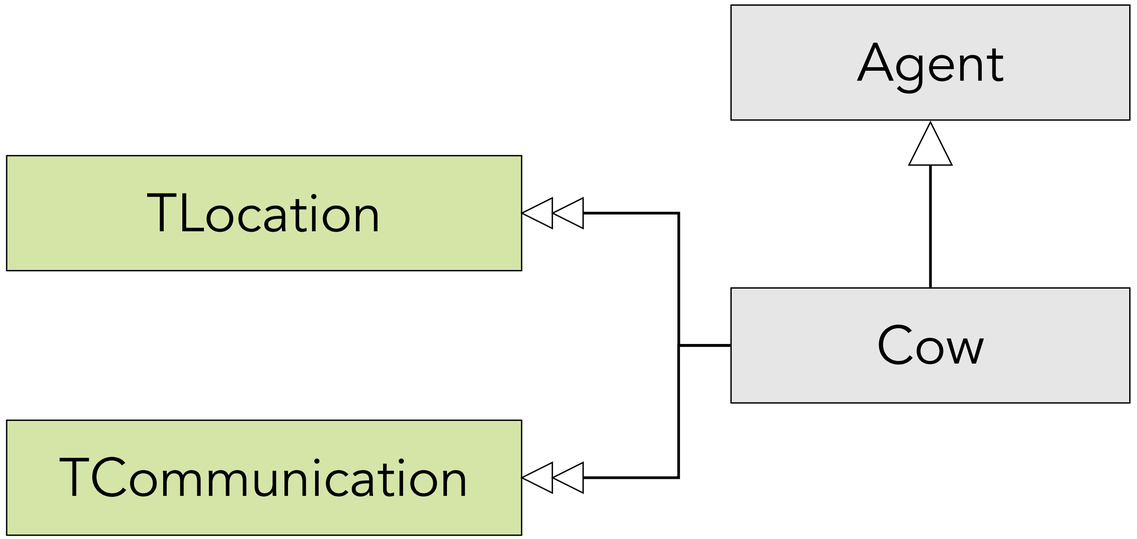
> *How hard would it be for geographer or biologist to use an ABM platform for the first time?*

Can we make it easier?
More intuitive?



Topic 1: Modelling Language

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

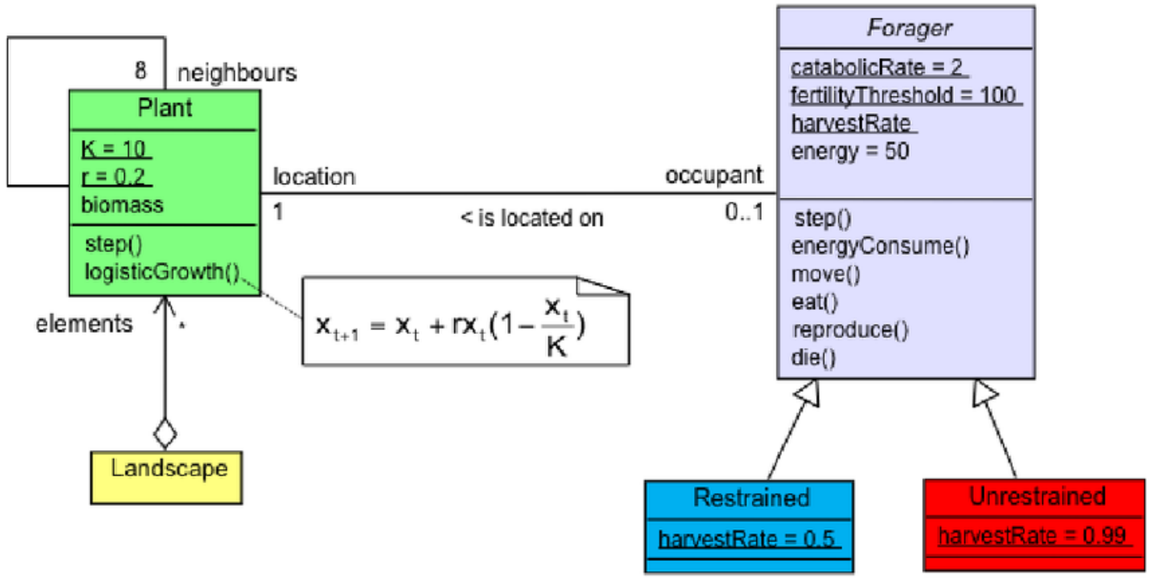


Solution 1: Object-oriented ABM

- 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:

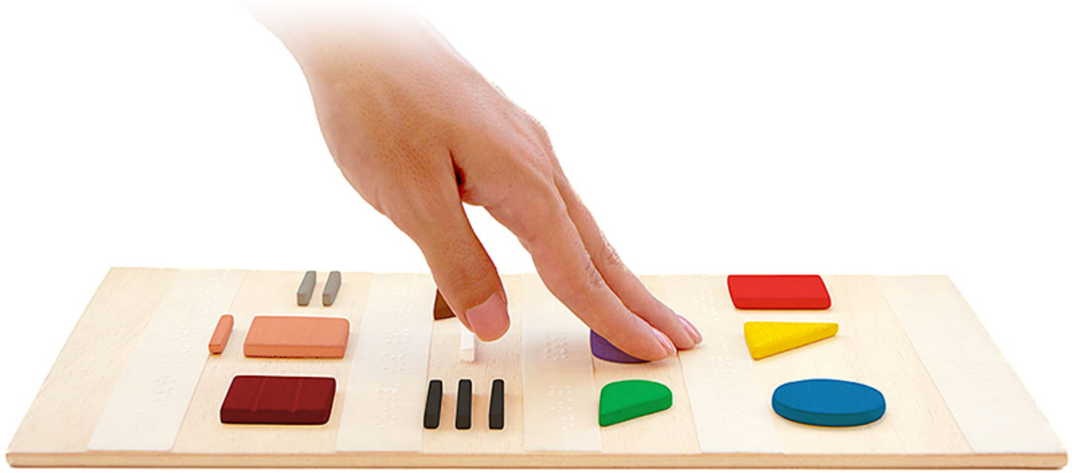
During the participatory sessions in the field, it is often difficult to put every participant in front of a computer and make them manipulate the model.

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

Caroline Dangleant © Cirad

Topic 2: Tangible Interaction

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

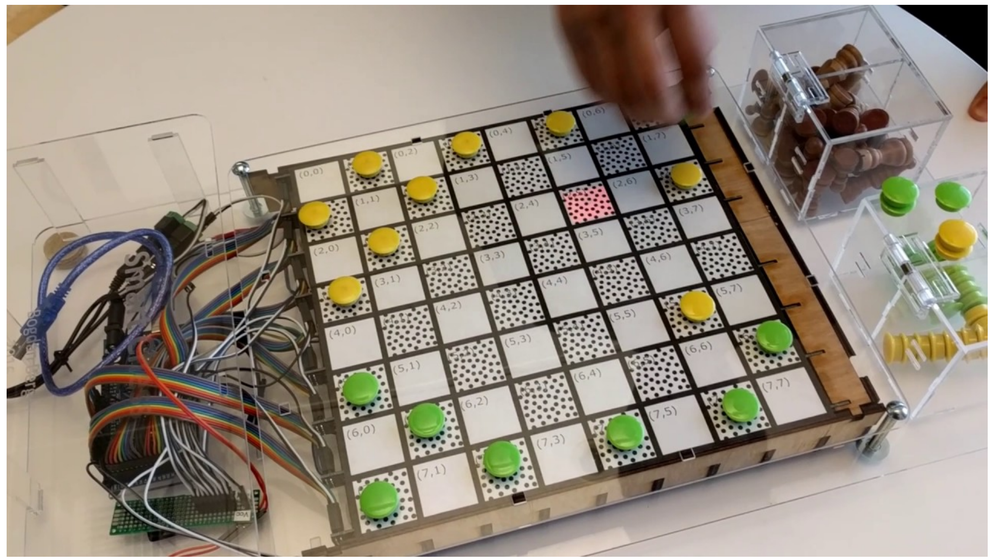


Hypothesis:

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?

Christophe LePage © Cirad

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?)

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)

WODEN Engine

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.

CORMAS

… 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 »