

European Smalltalk User Group (ESUG) — Lille, 9 July 2024

# Participatory Agent-Based Modelling and Serious Games with Cormas on Pharo

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SENS (**S**avoirs, **EN**vironnement, **S**ociétés = Knowledge, Environment, Societies): a mixed research unit in 3 institutes: CIRAD, IRD and University.

Multidisciplinary team between the **social sciences** (anthropology, economics, geography, sociology, law, political science), **life and environmental sciences** (agronomy and ecology) and **sciences and technologies** (modeling and computer science).

For 25 years, we have been developing an ABM platform to help manage natural resources.



An aerial photograph of terraced rice fields on a hillside. The fields are arranged in concentric, curved rows, creating a rhythmic pattern of green and yellow. A small, traditional thatched-roof hut is situated in the middle of the terraces. The surrounding area is lush with green vegetation and trees.

**Part 1:**

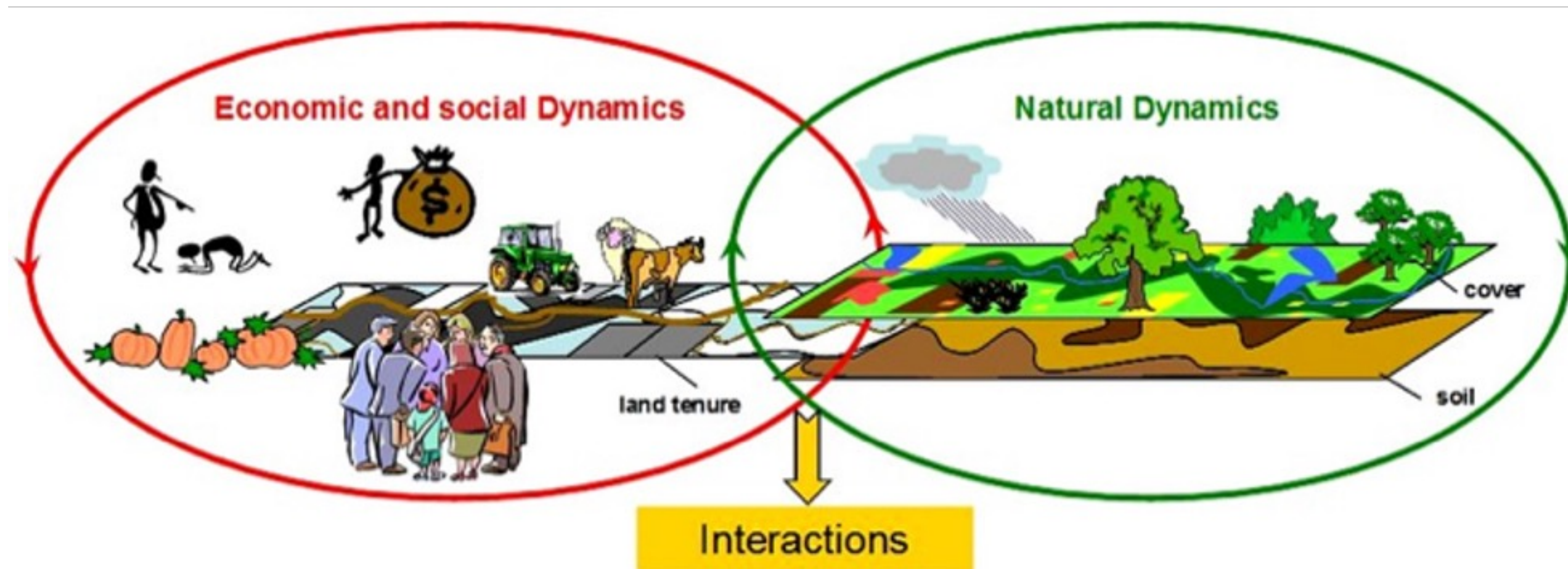
**Agent-based modelling**



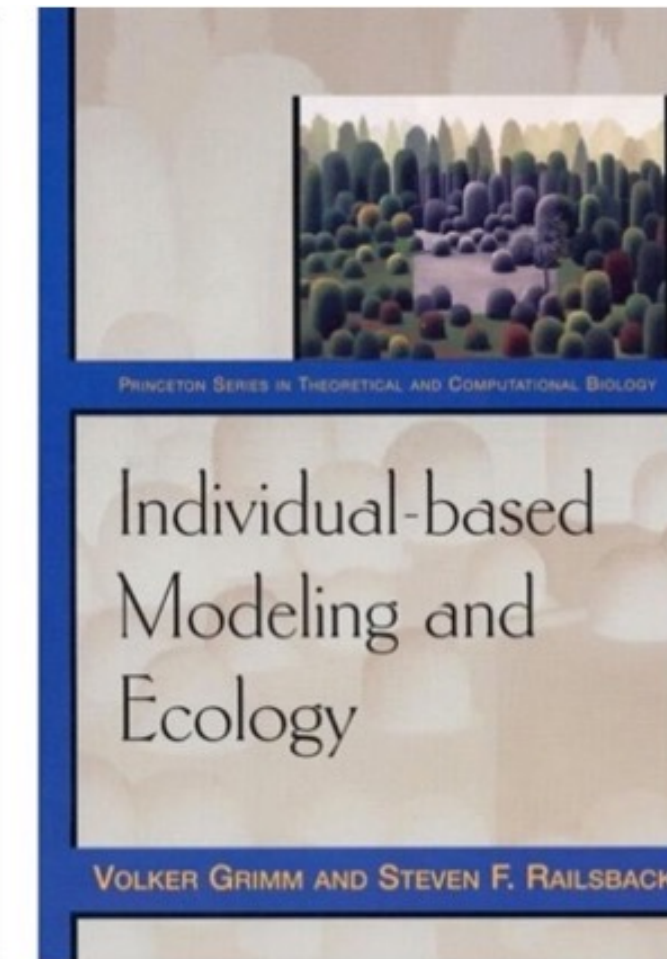
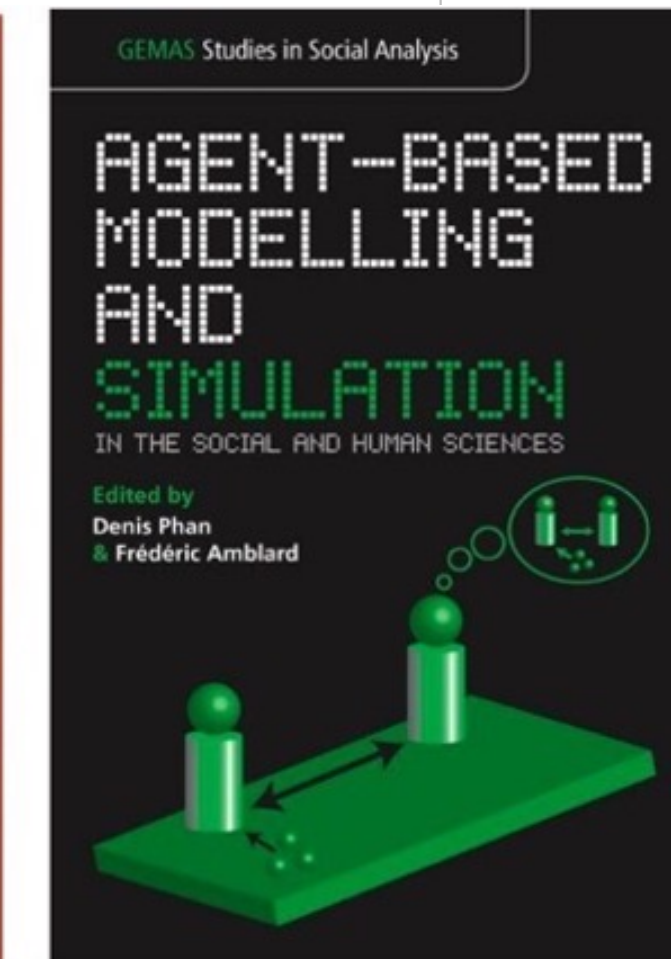
# ABM to simulate socio-eco-system



Crossing various dynamics



- Understanding socio-ecological systems (SES)
- Consequences between individual practices in interaction with natural resources' dynamics.
  - Explore various modes of collective organization





# ABM to articulate Micro/Macro levels



## Methodological individualism

Raymond Boudon  
Max Weber

## Methodological holism

Emile Durkheim  
Pierre Bourdieu

## Reciprocal dependencies

Norbert Elias

## Theory of structuration

Anthony Giddens

**Macro level**

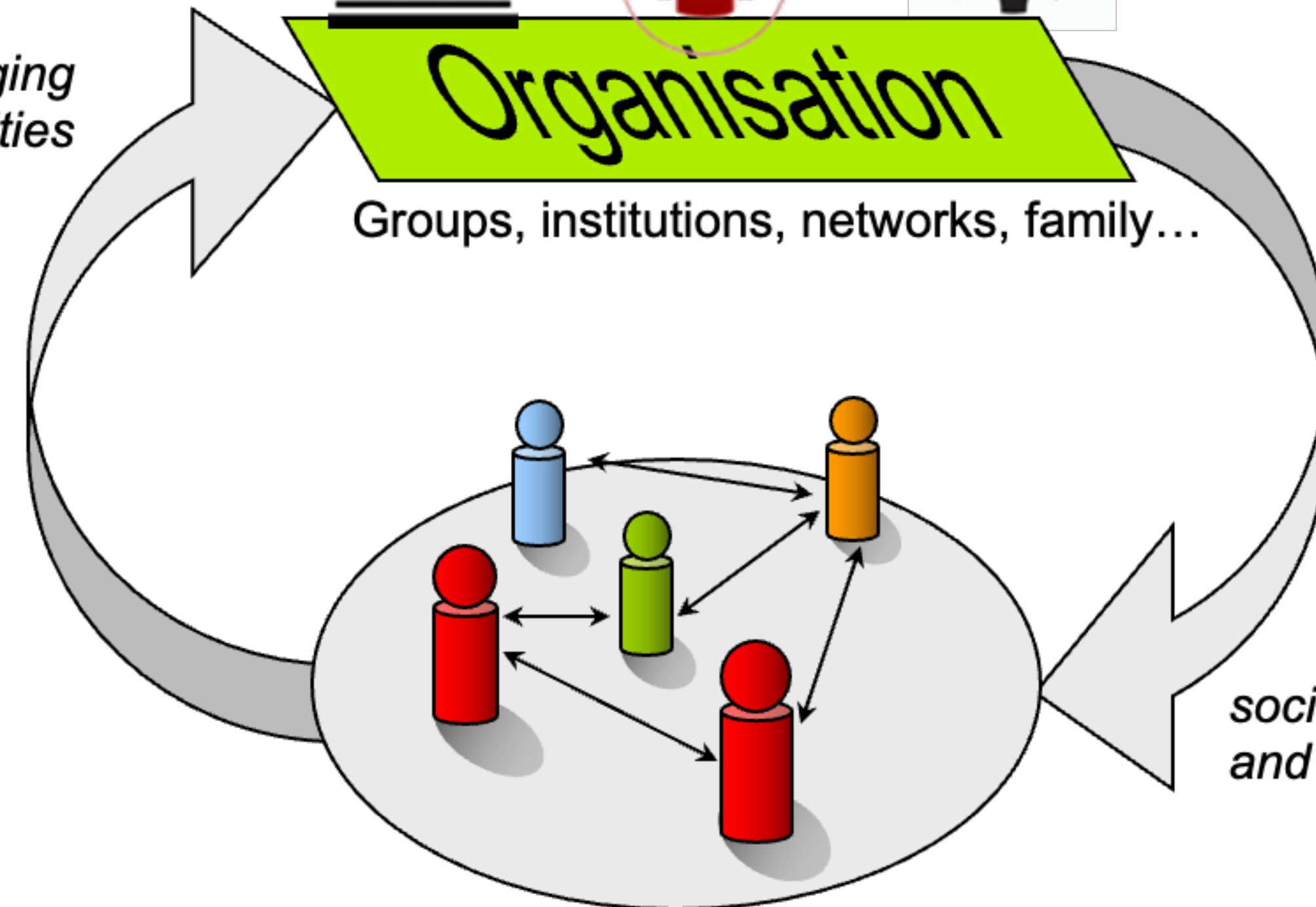
*emerging functionalities*



Groups, institutions, networks, family...

Emergence,  
Auto-organisation

**Micro level**



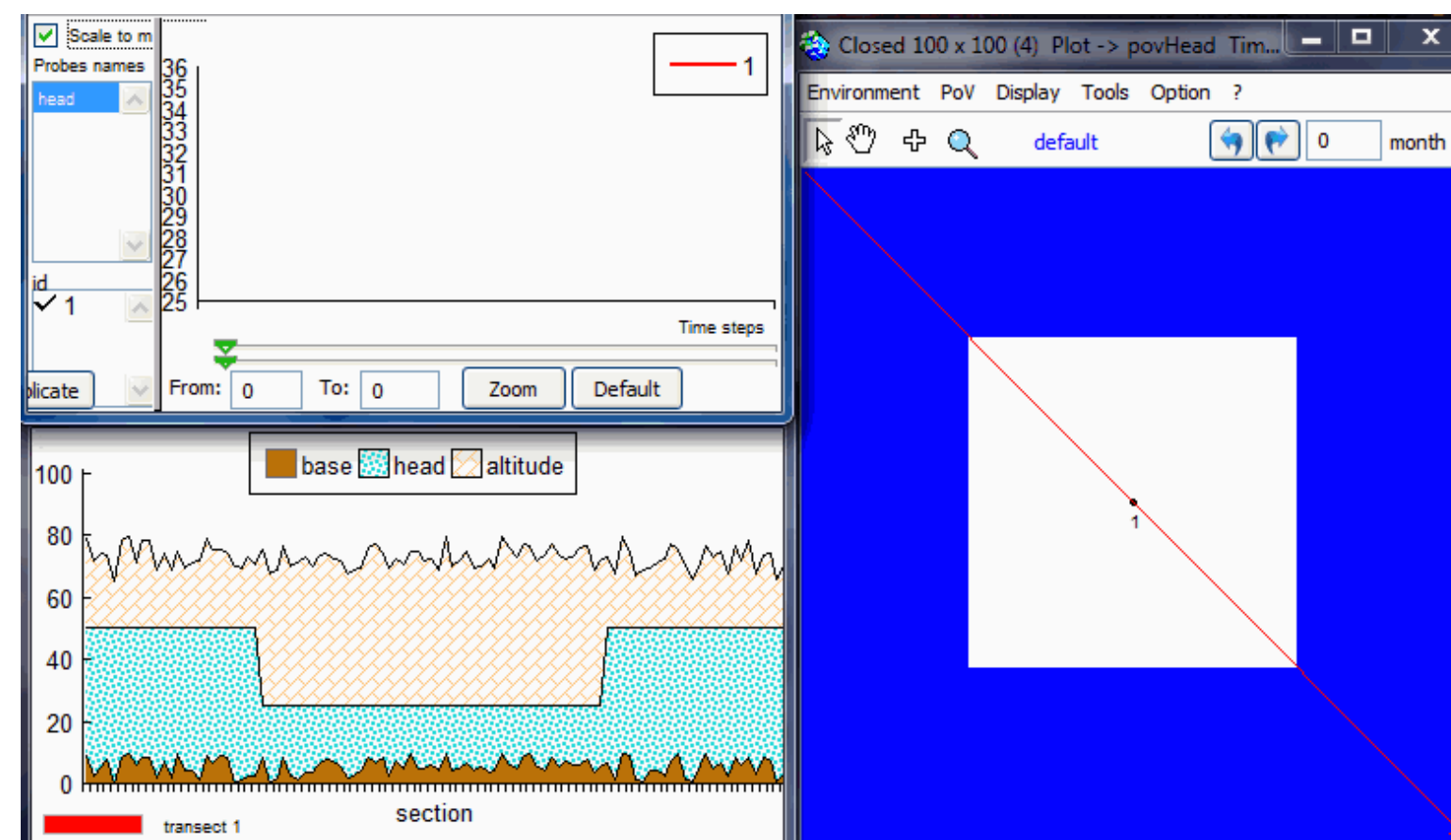
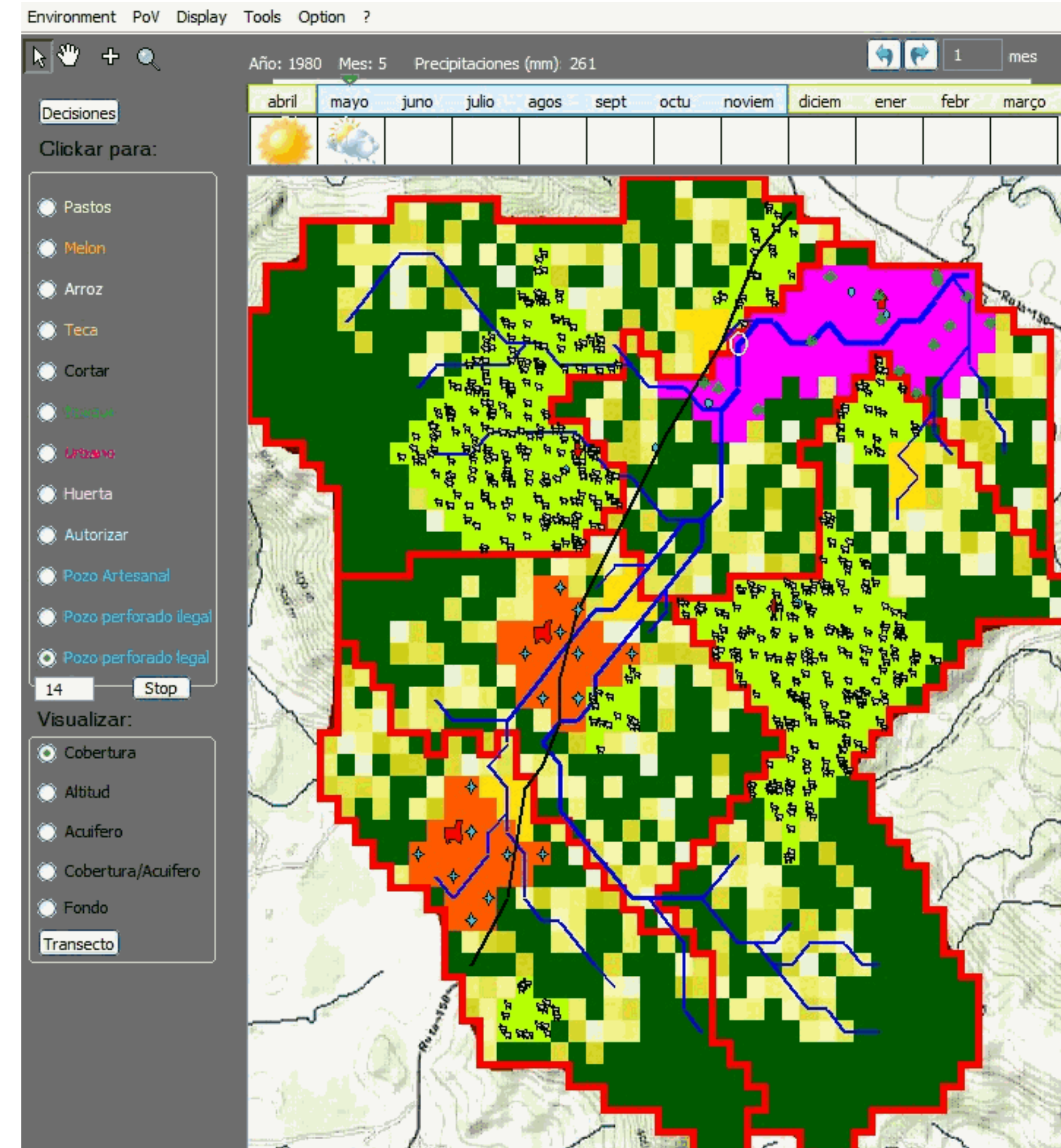
*social constraints  
and social goals*



# ABM examples (Cormas VW)



## Groundwater pollution in Costa Rica

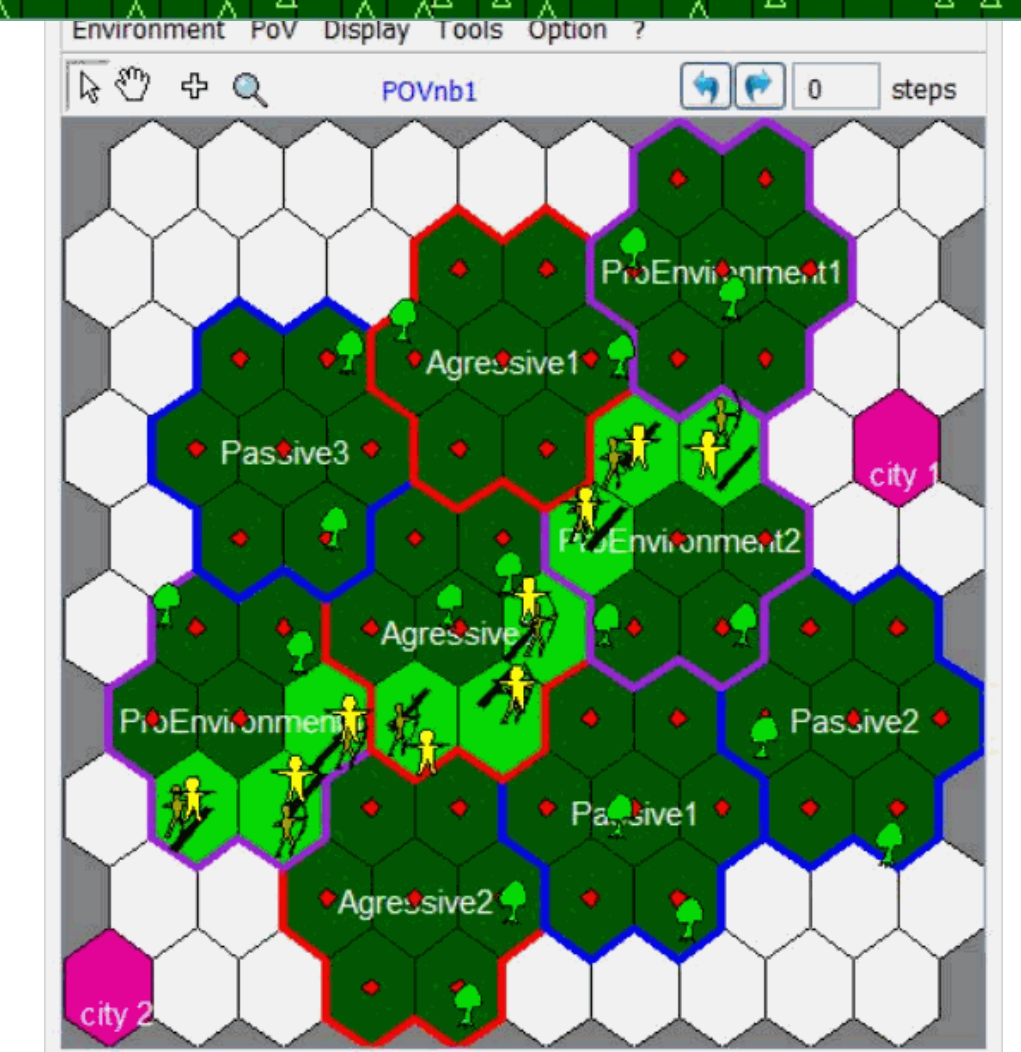
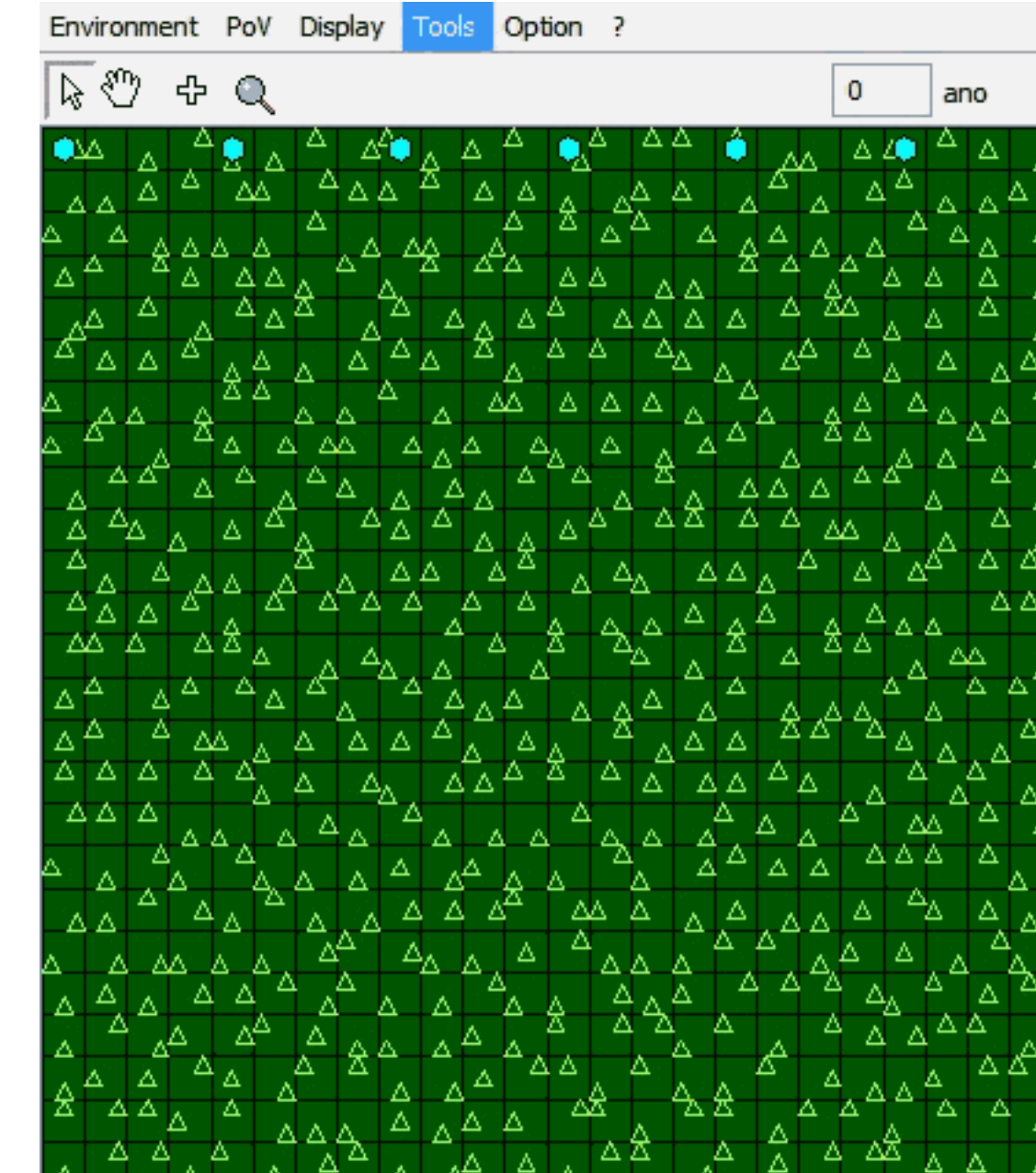
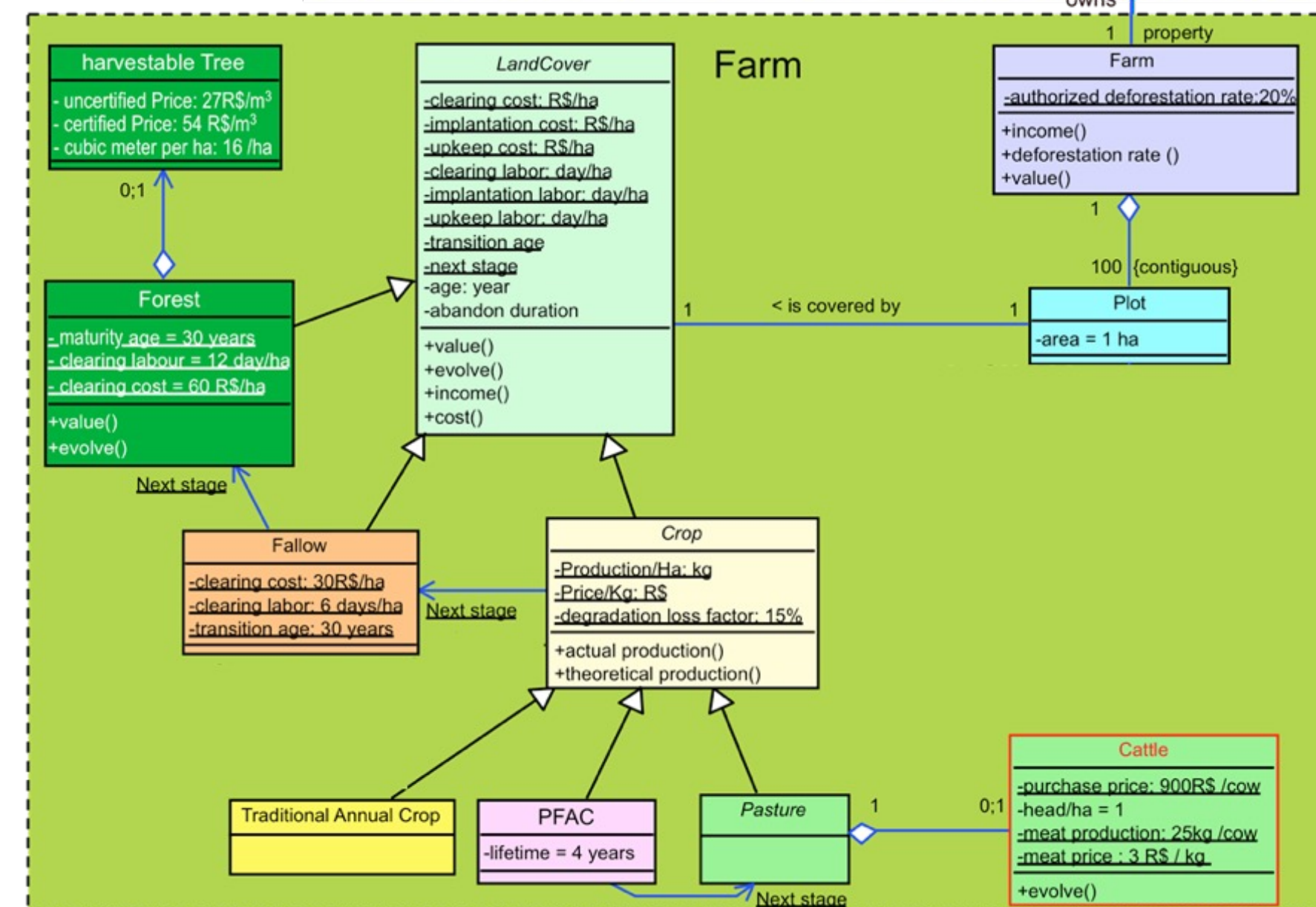
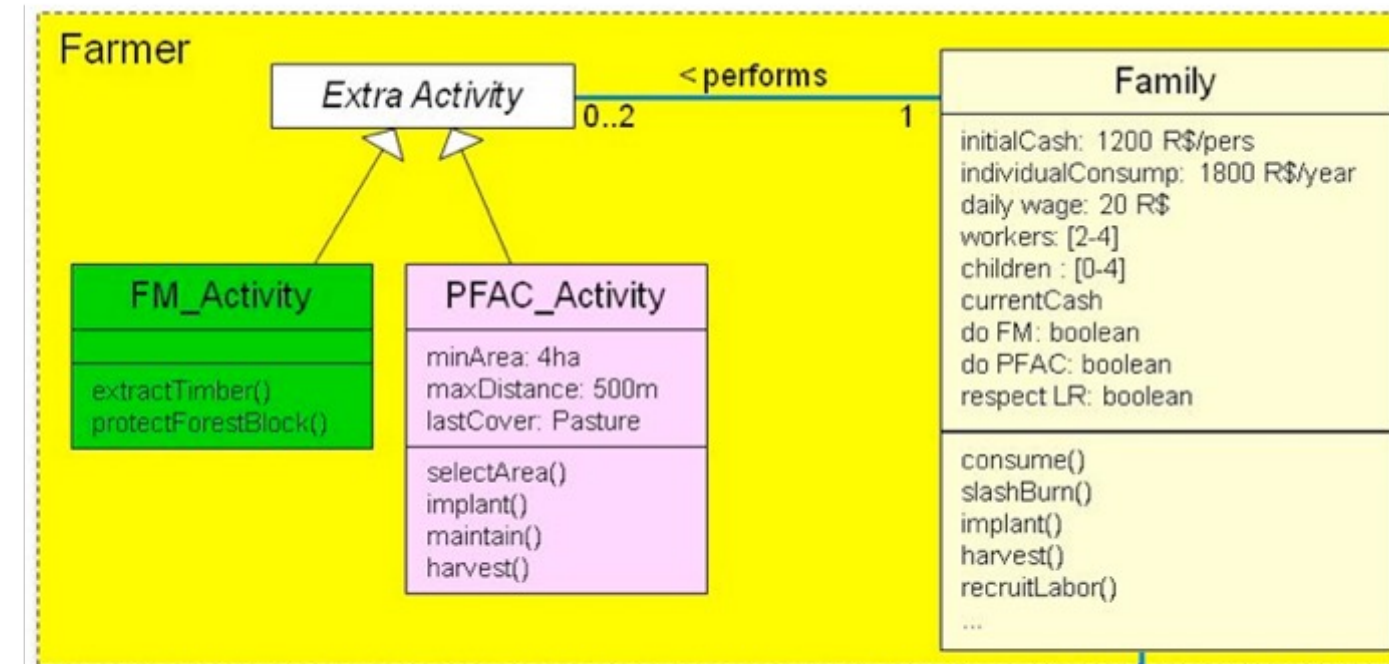
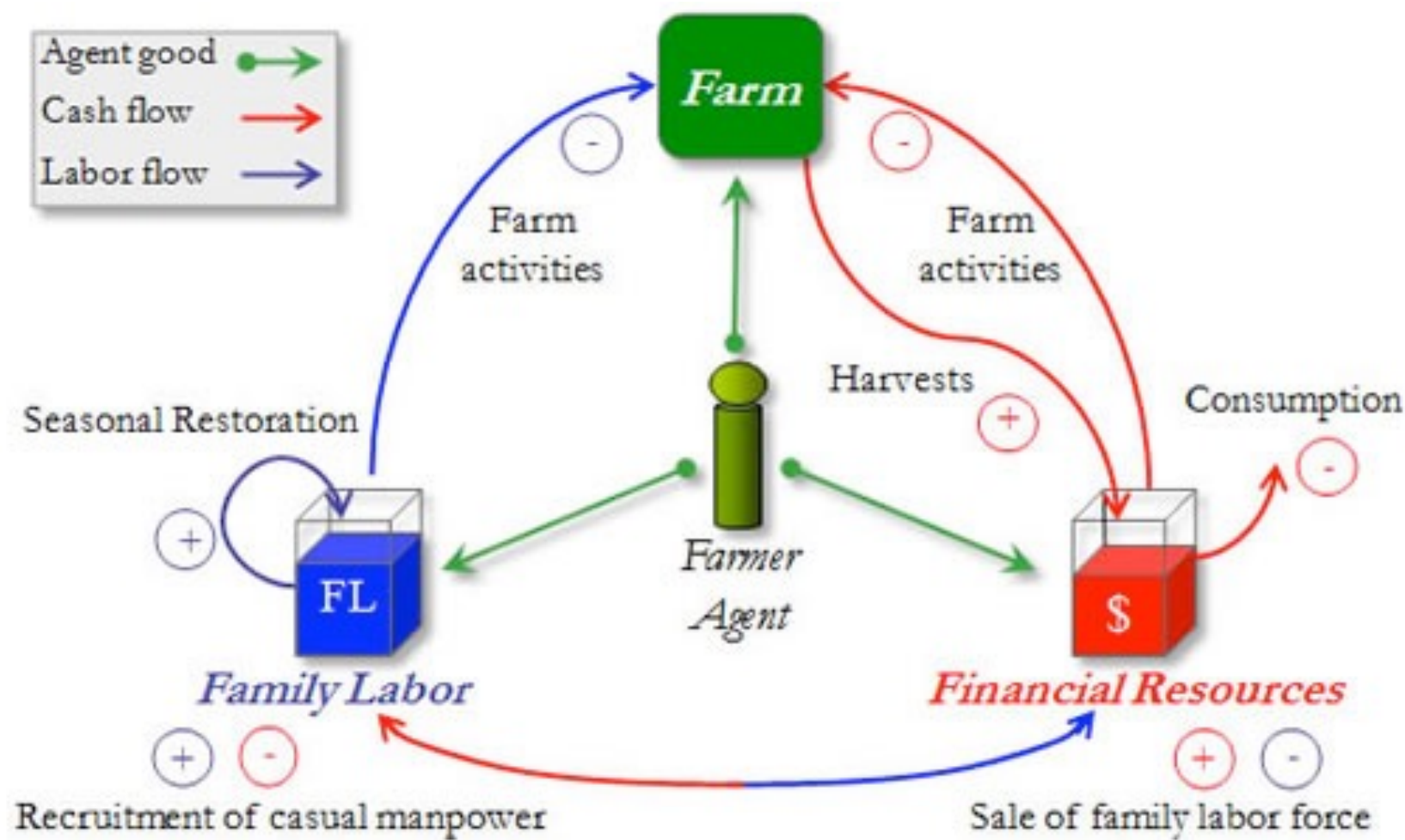




# Example of ABM (Cormas VW)



Alternative farming practices to deforestation in the Amazon



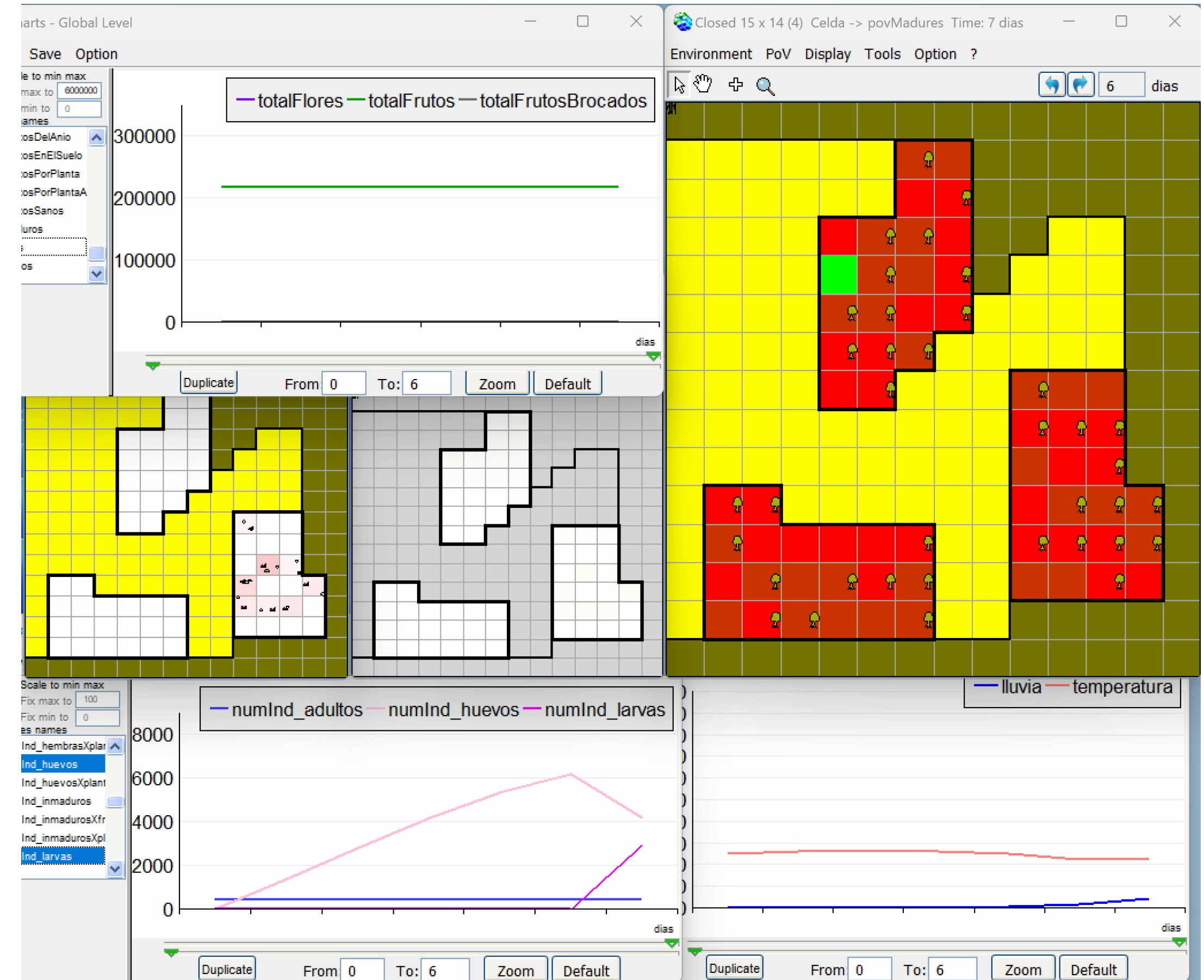
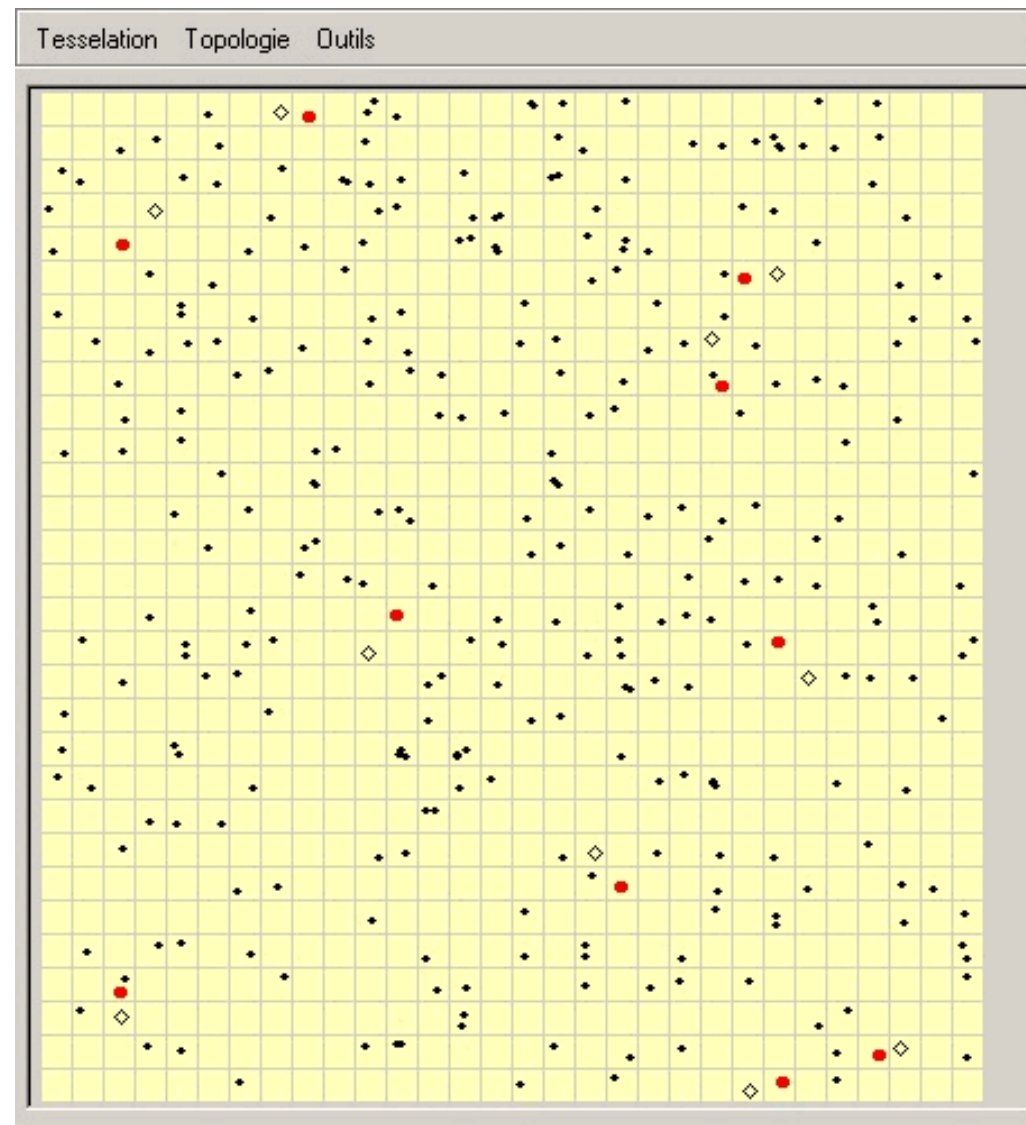


# Example of ABM (Cormas VW)



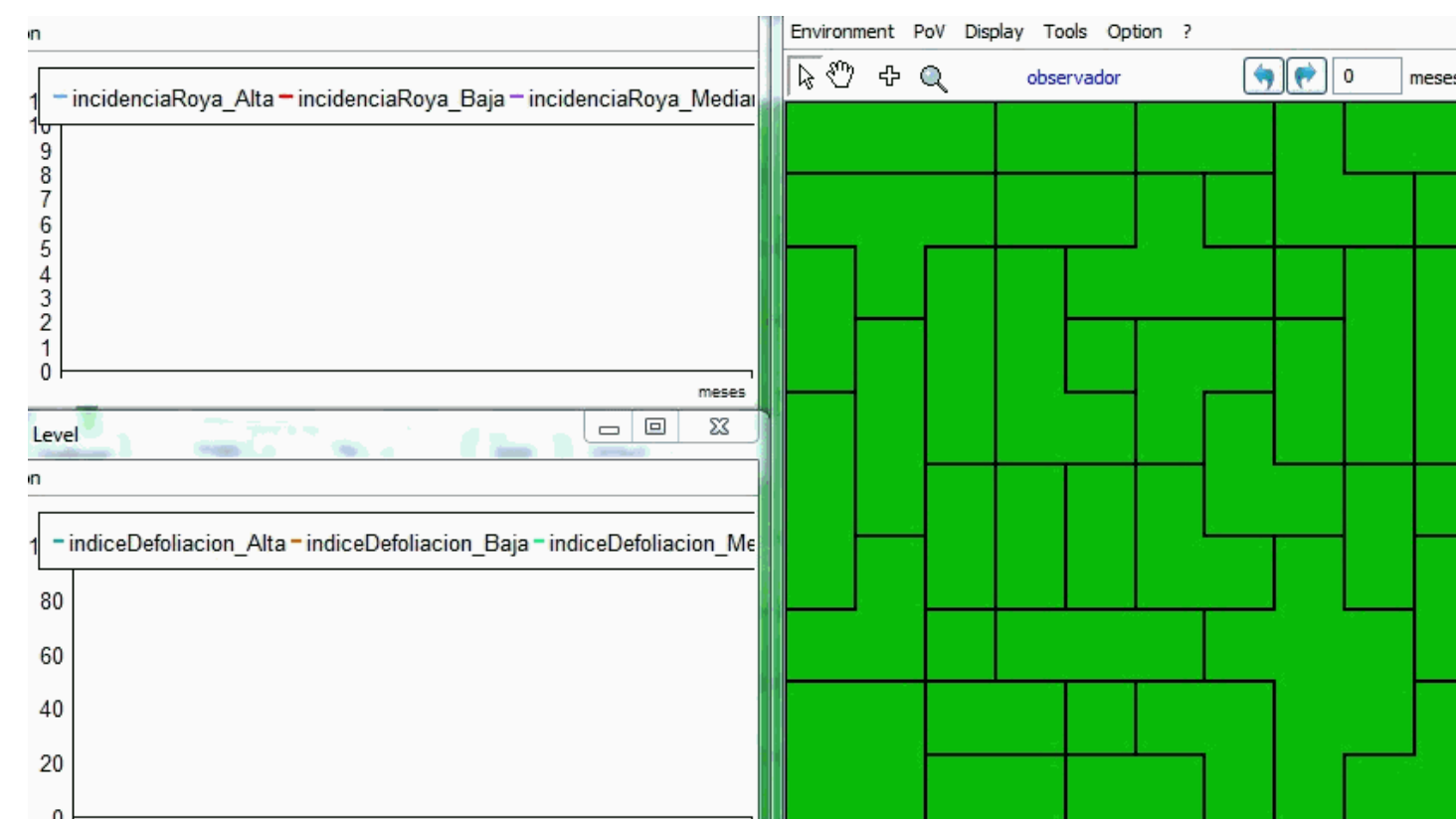
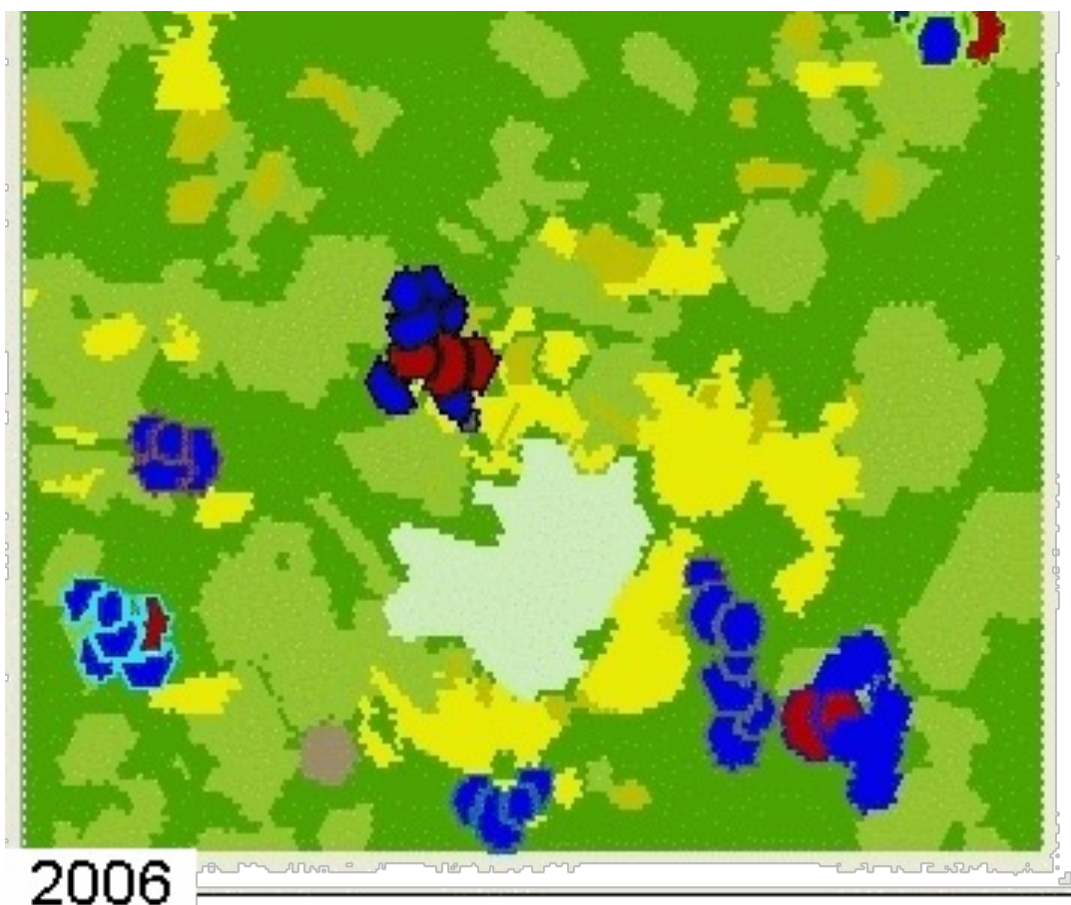
Emergence of resource-sharing conventions

Network evolution



Savannah landscape mosaic under shifting cultivation, North Cameroon

Coffee rust spread in Nicaragua



CBB spread in Central America



# Unique Features of Cormas

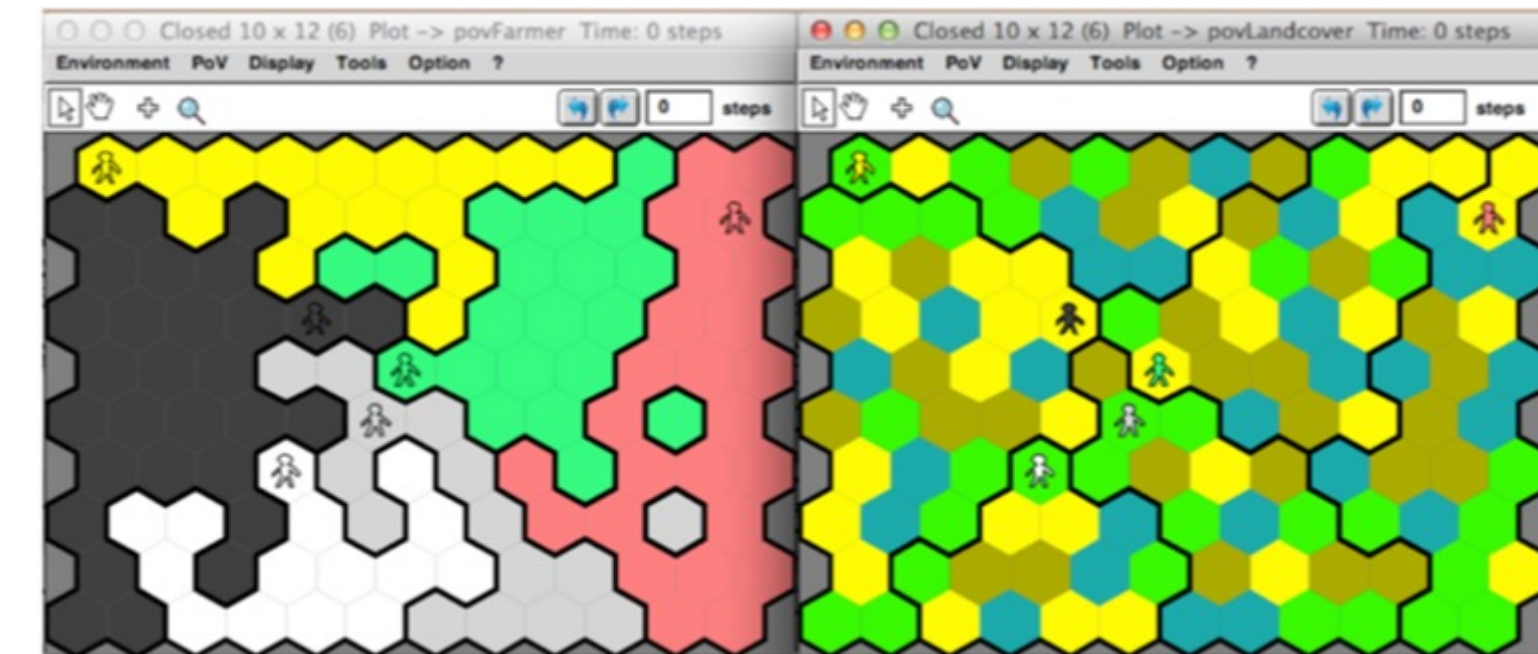


... that make it well-suited for companion modelling



## Different « Points of View »

Observe a simulation from different perspectives at the same time (multi-windowing)



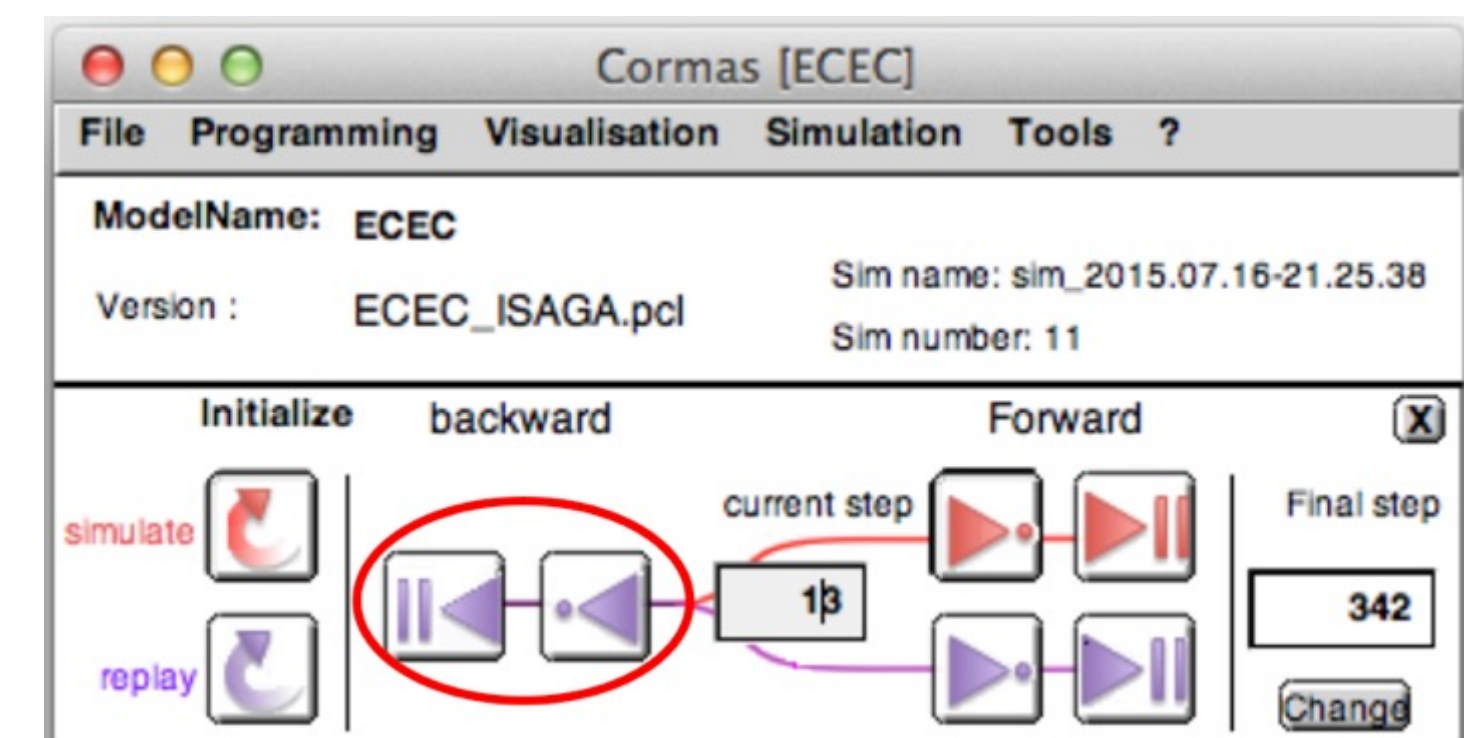
## Live dynamic environment where everything is an object

Interact with anything at any time without stopping the simulation



## Stepping back in time

Move back the time, change conditions, continue on alternative path





# Immersive coding



*Thanks to Smalltalk, Cormas benefits from*

## A reflexive language

*Introspection, to inspect and analyse any object of the simulation*

*Intercession, to amend its semantic and behaviour*

## A powerful debugger

*Takes the modeler to the heart of his simulation*

*Offers a more substantive vision of the way it operates.*

*Put yourself in the place of the agent*

## Debugging is a learning process in itself

*Live coding*

*Helps modellers check their model*

*Develop models directly from the debugger.*

**A great language to prototype  
a model and check it works**

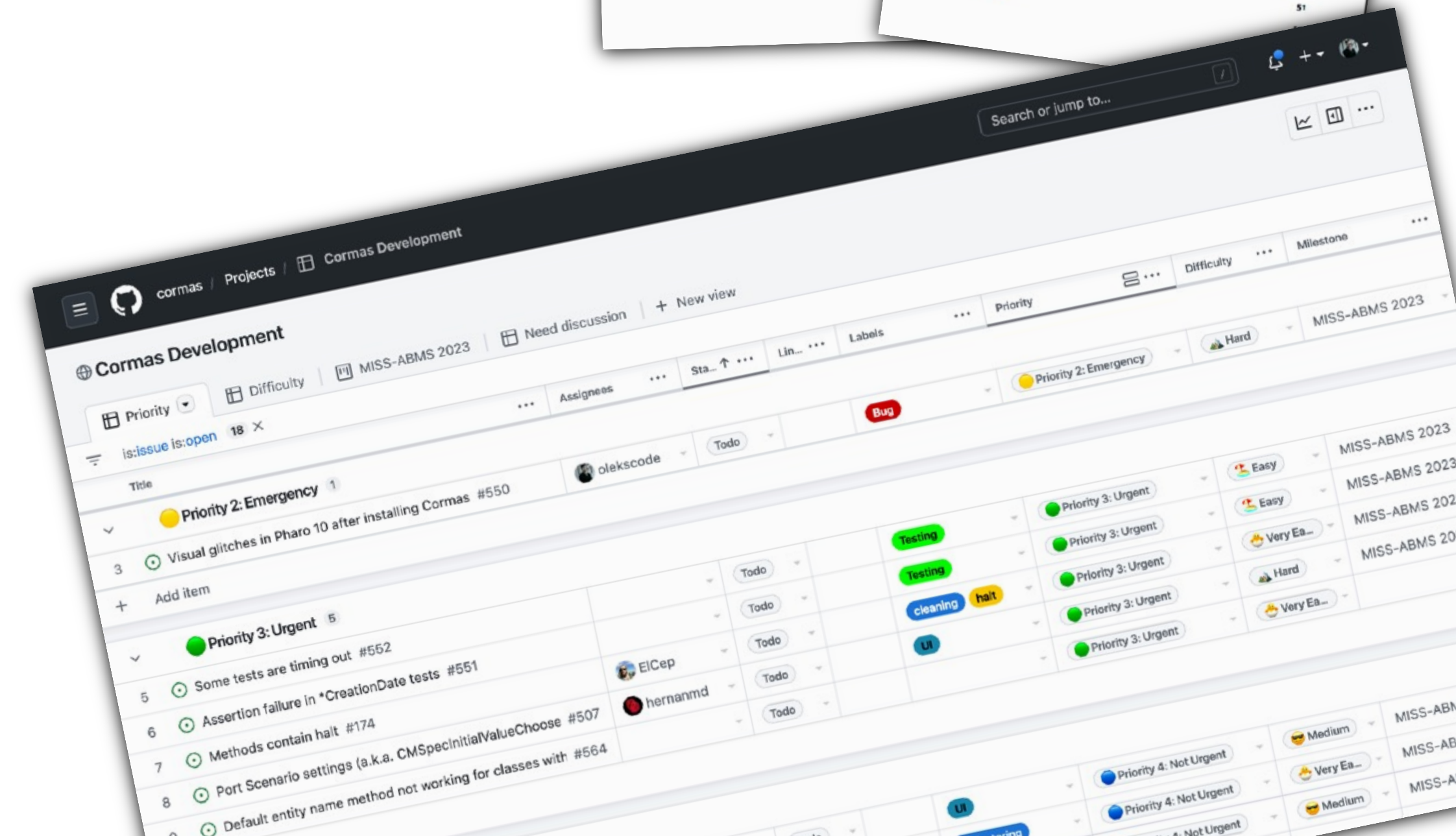
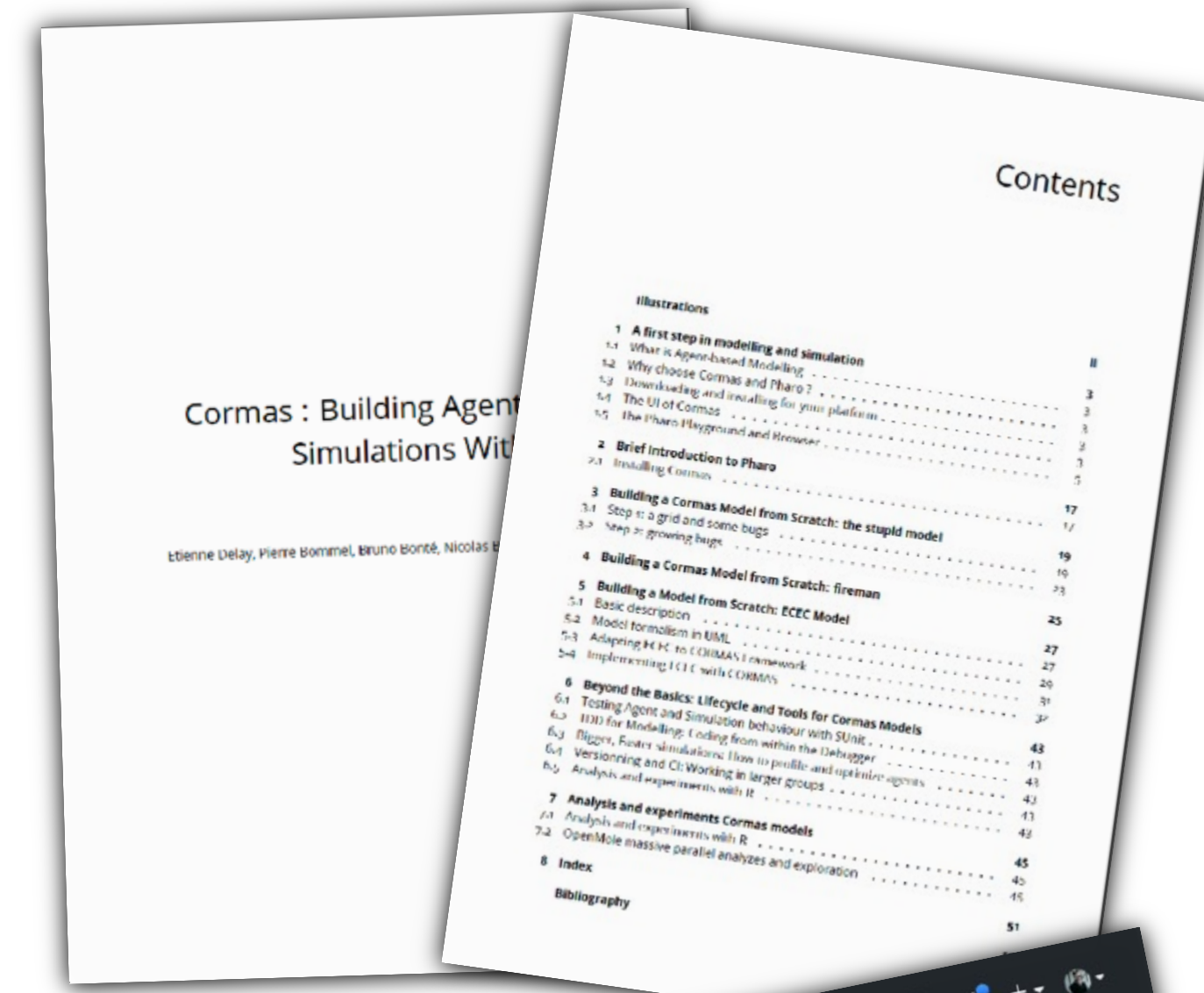


# Cormas Platform



COmmon pool Resources  
and Multi-Agent Simulations

- ✓ Based on years of field experience
- ✓ Now, implemented in **Pharo**
- ✓ MIT Licence
- ✓ Dynamic community
- ✓ Well-suited for **companion modelling**







# Part 3:

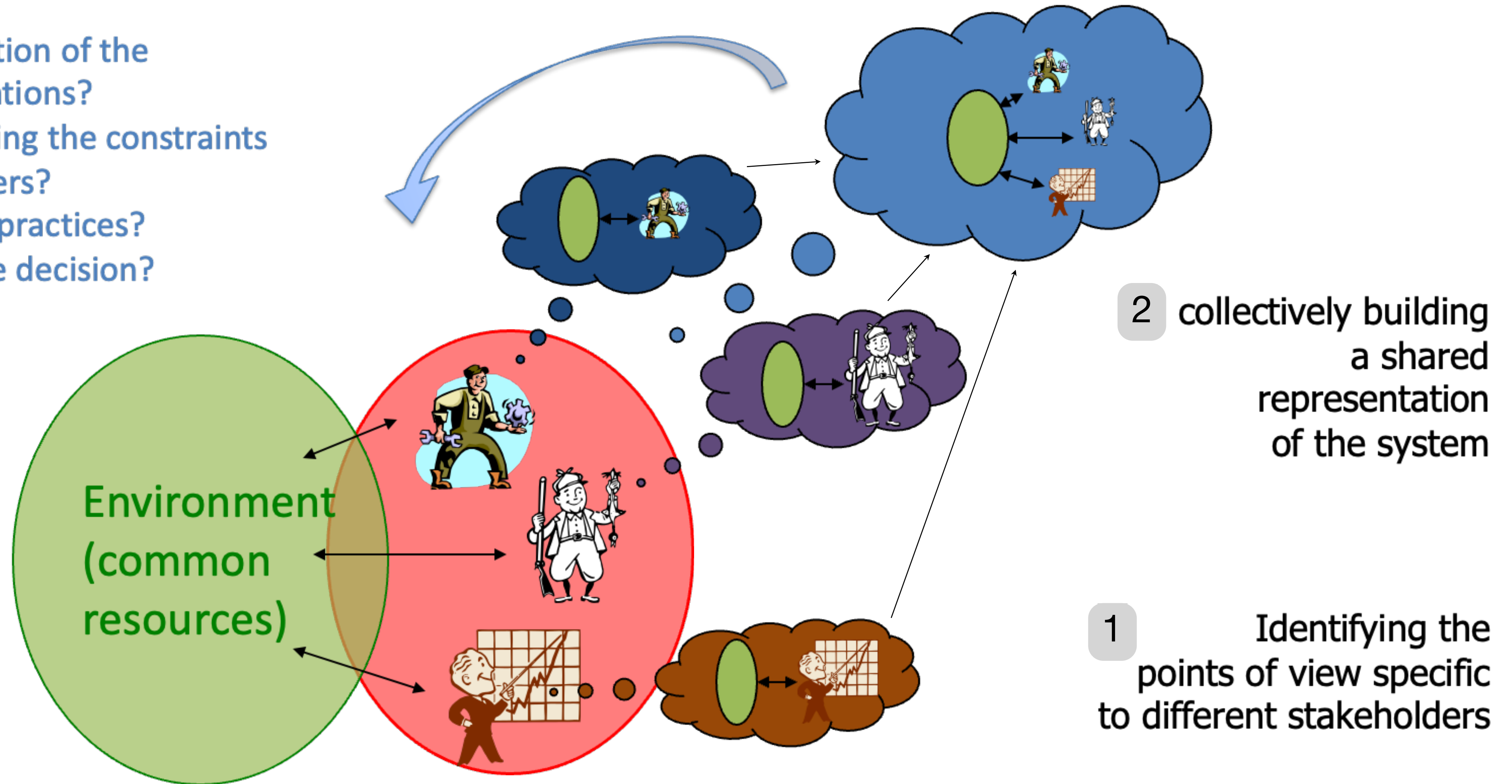
## The Companion Modelling Approach

*ComMod*



# Companion Modelling

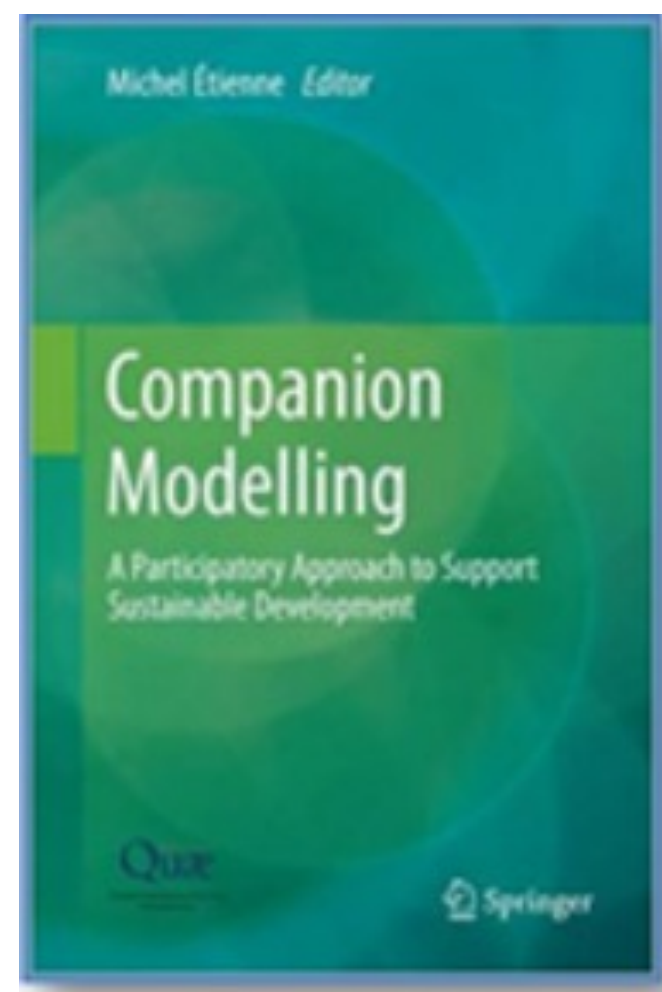
- 3
- Modification of the representations?
  - Considering the constraints of the others?
  - Changes practices?
  - Collective decision?



2 collectively building a shared representation of the system

1 Identifying the points of view specific to different stakeholders

Do not provide "ready to use" solutions





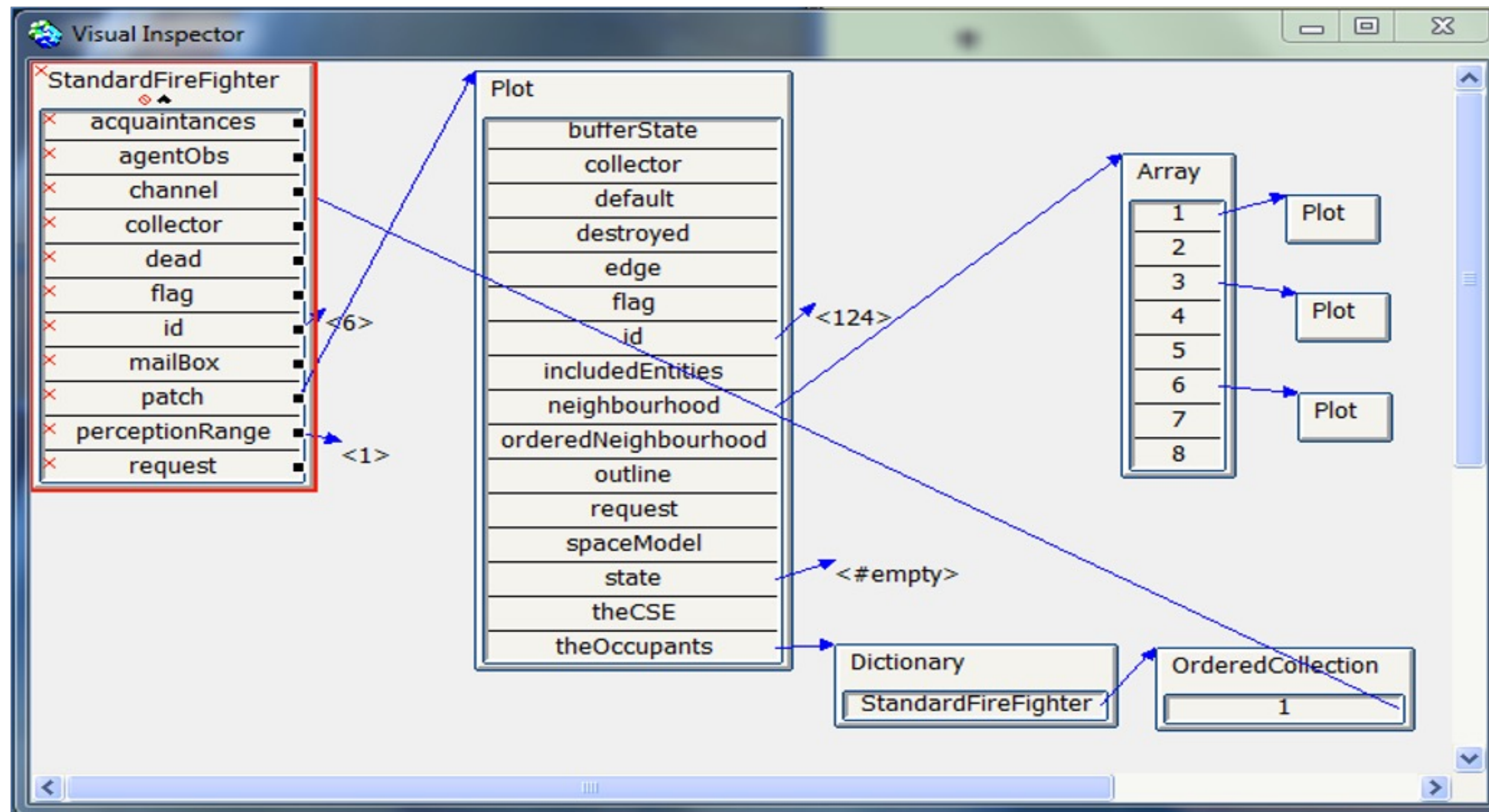
# Designing with UML



**Object diagram:** Editor to help modeling beginners understand object-based concepts



Visual inspector

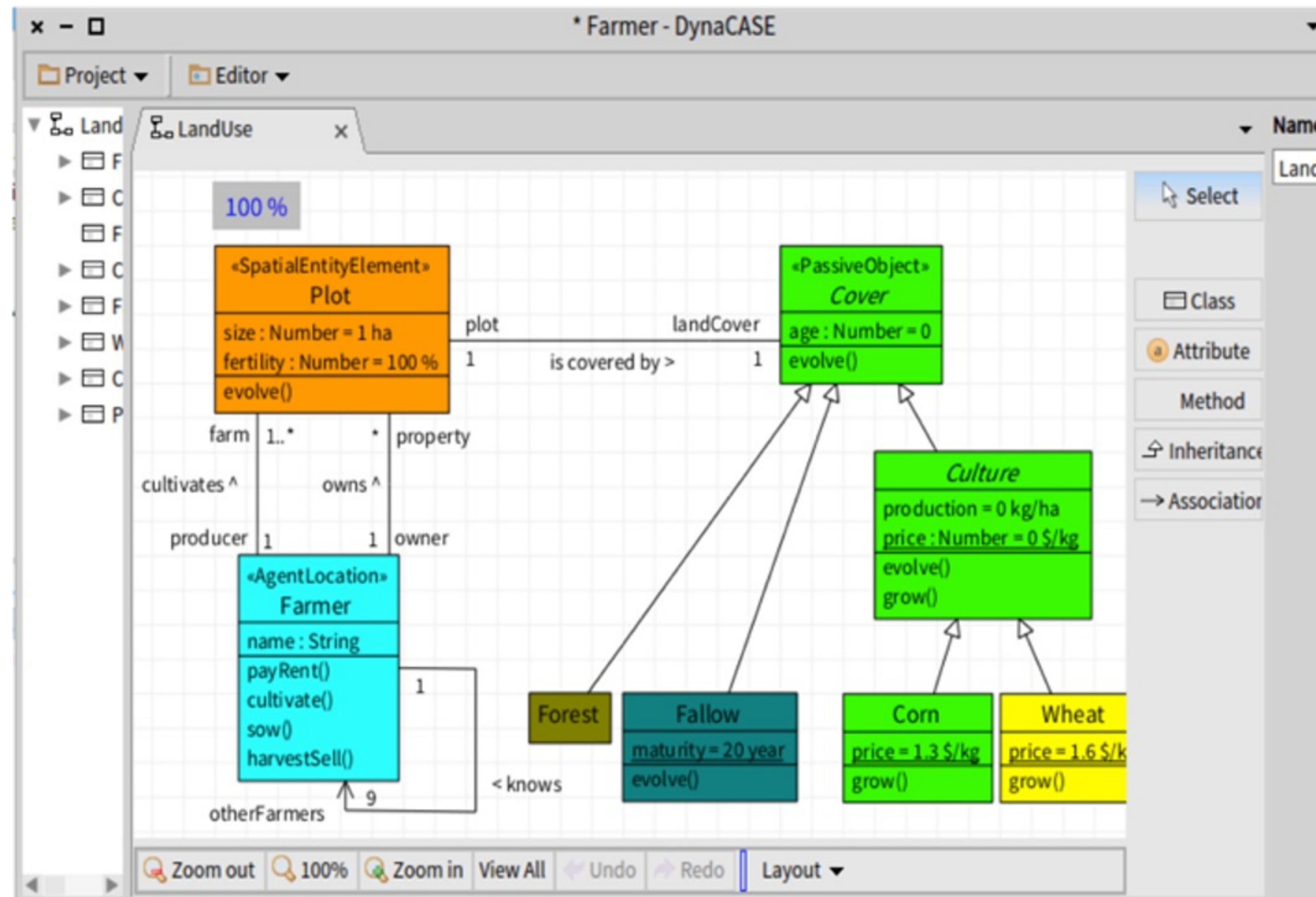




# Designing with UML



**Class diagram:** Editor for collaborative modelling and generating the structure of the code



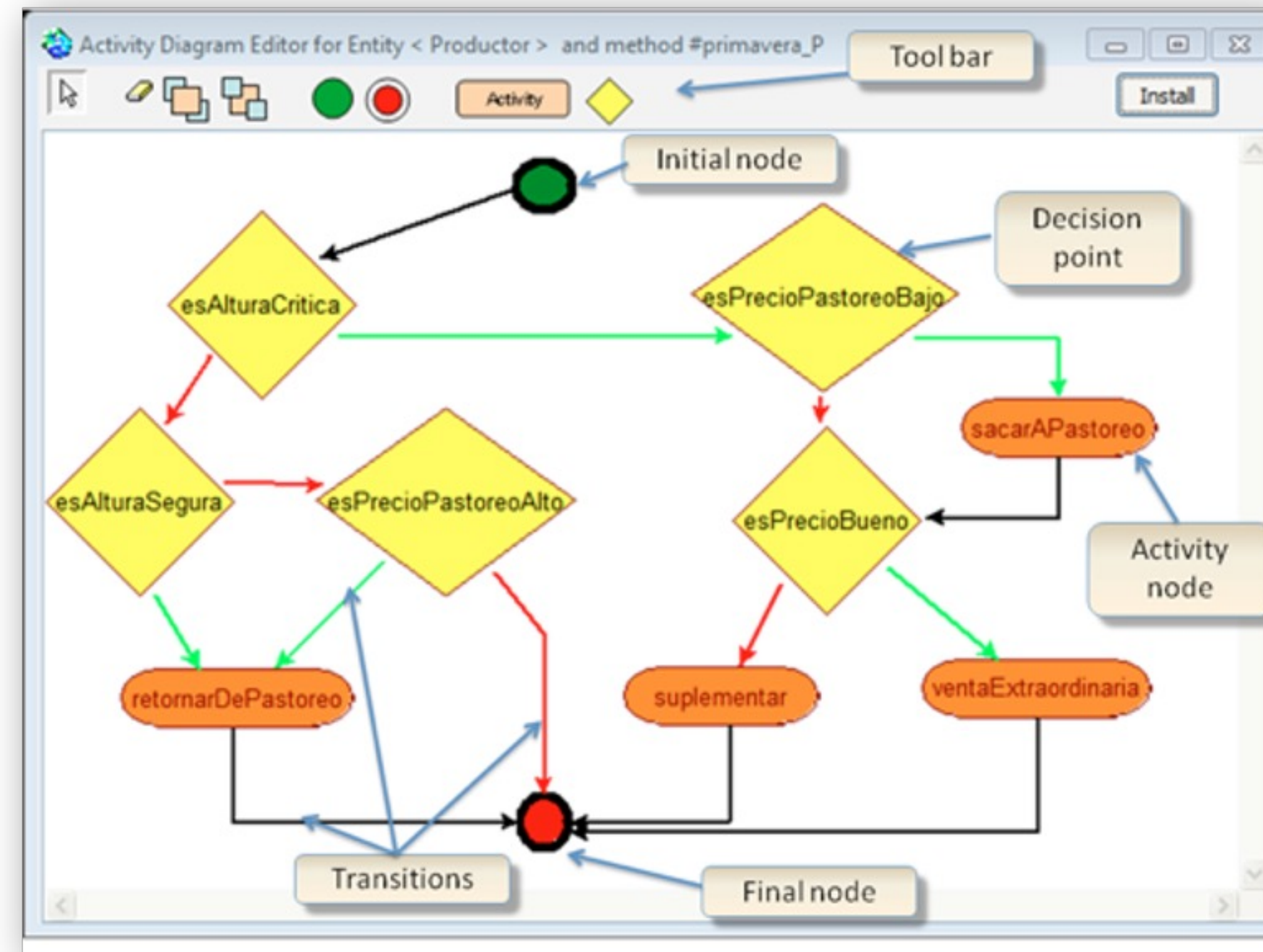
(Uhnak & Bommel 2016)



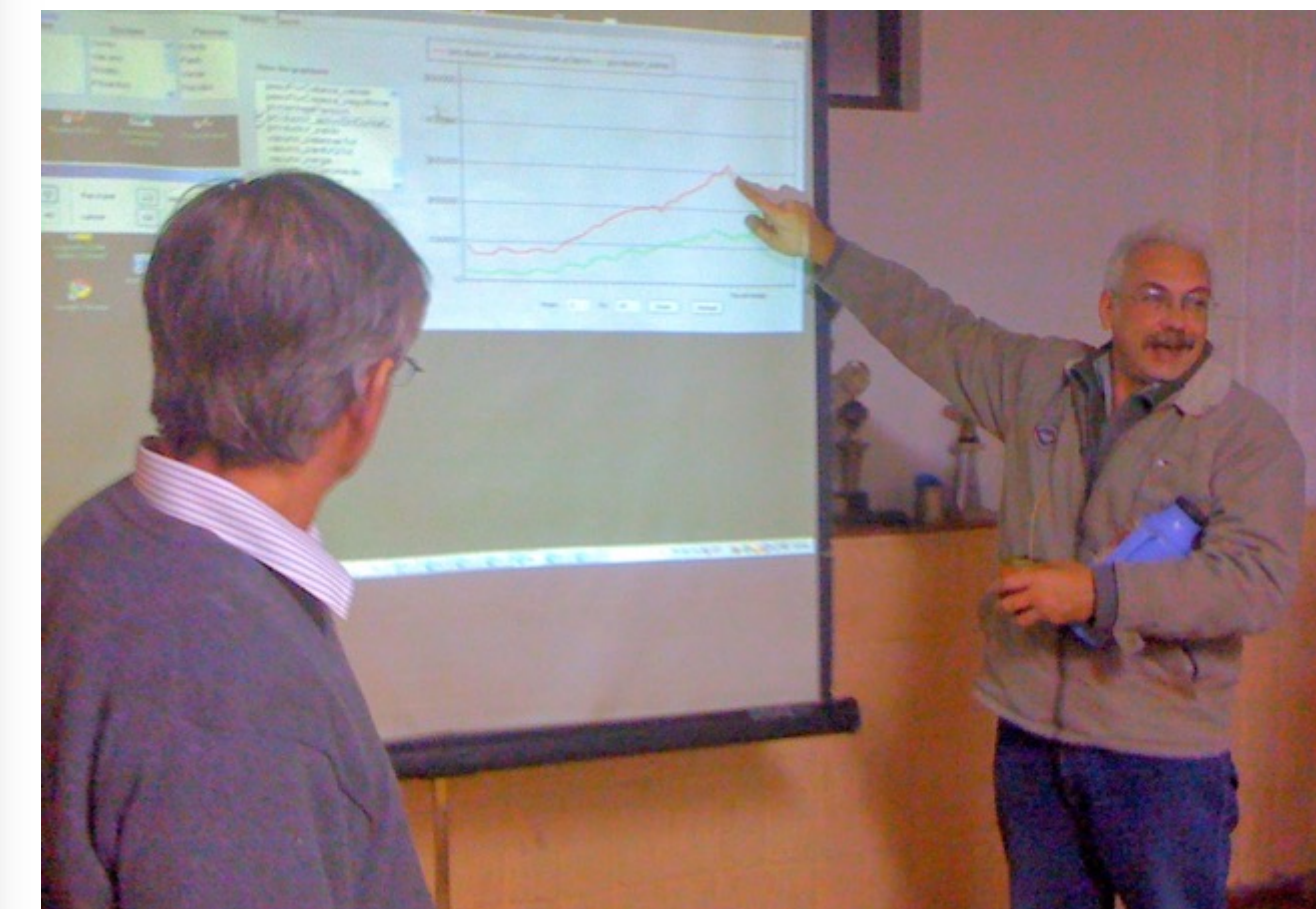
# Collective designing with UML



**Activity Diagram:** Editor to modify the decision rules of an agent and execute its behaviour



Farmers analysing activity diagrams



Farmer explaining a simulation



Bommel P., Dieguez F., Bartaburu D., Duarte E., Montes E., Pereira M., Corral J., Lucena C. and Morales H., (2014). A Further Step Towards Participatory Modelling. Fostering Stakeholder Involvement in Designing Models by Using Executable UML. Journal of Artificial Societies and Social Simulation 17 (1) 6.





**Part 4:**

**Serious Games**



# What are Serious Games?



Games that are used for purposes other than entertainment

## Example: Military



## Example: Railroad Planning





# What are Serious Games?



3 types of Serious Games use





# How do we use them at CIRAD?



## Games for intervention

**Role-Playing Games (RPG)** - players assume roles of characters in fictional setting: farmers, fishermen, policemen, government, animals, etc.

**Games are highly accessible**

Even people who cannot read or write and have never used a computer can participate in a simulation represented on a game board

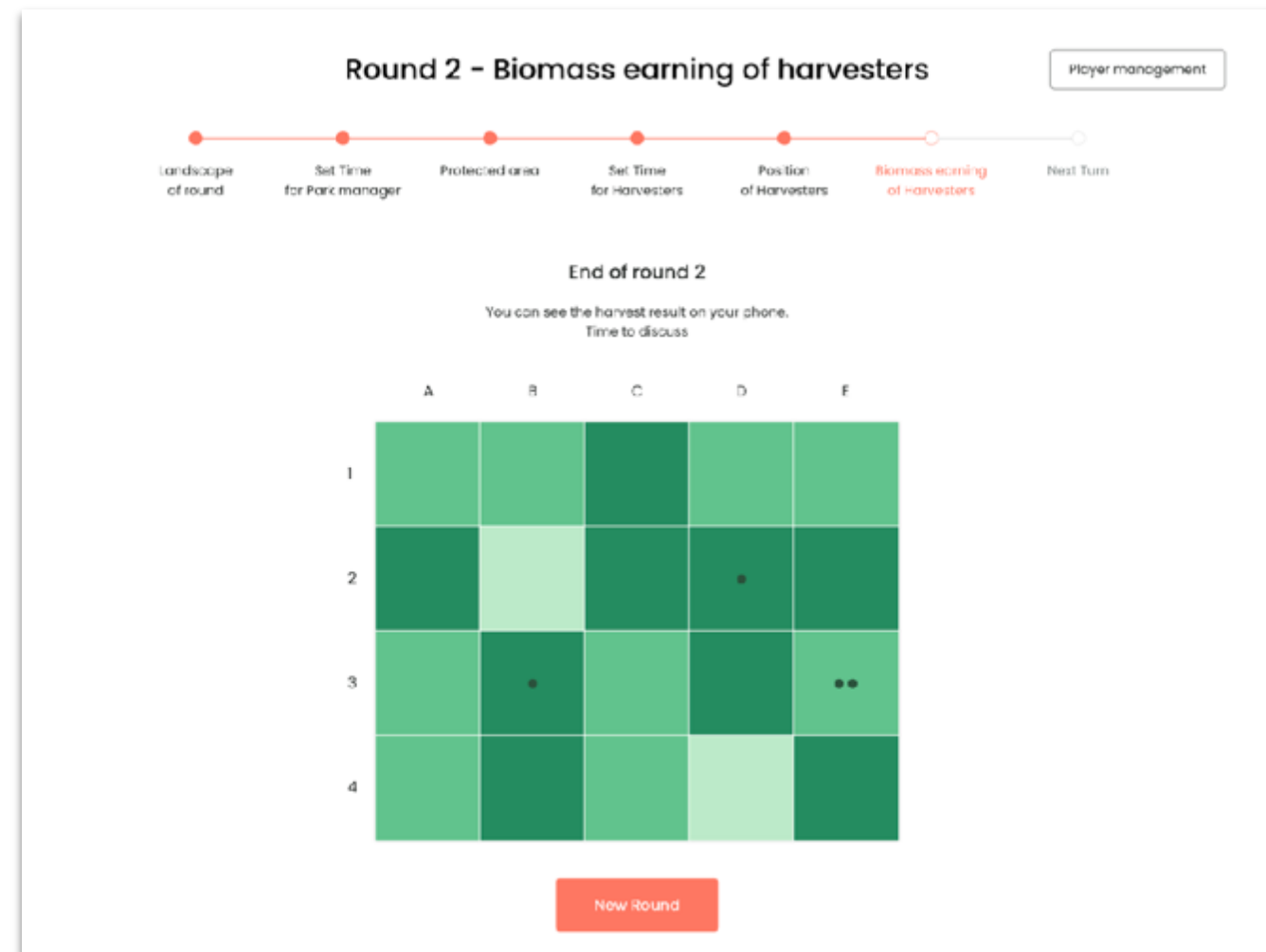




# Example of game: Planet C



"Because there is no Planet B"



An interactive, collaborative game that uses collective intelligence to manage resources

designed to make you rethink your beliefs and empower you as an Architect of Change



Haute école spécialisée bernoise



<https://planetc.org/>



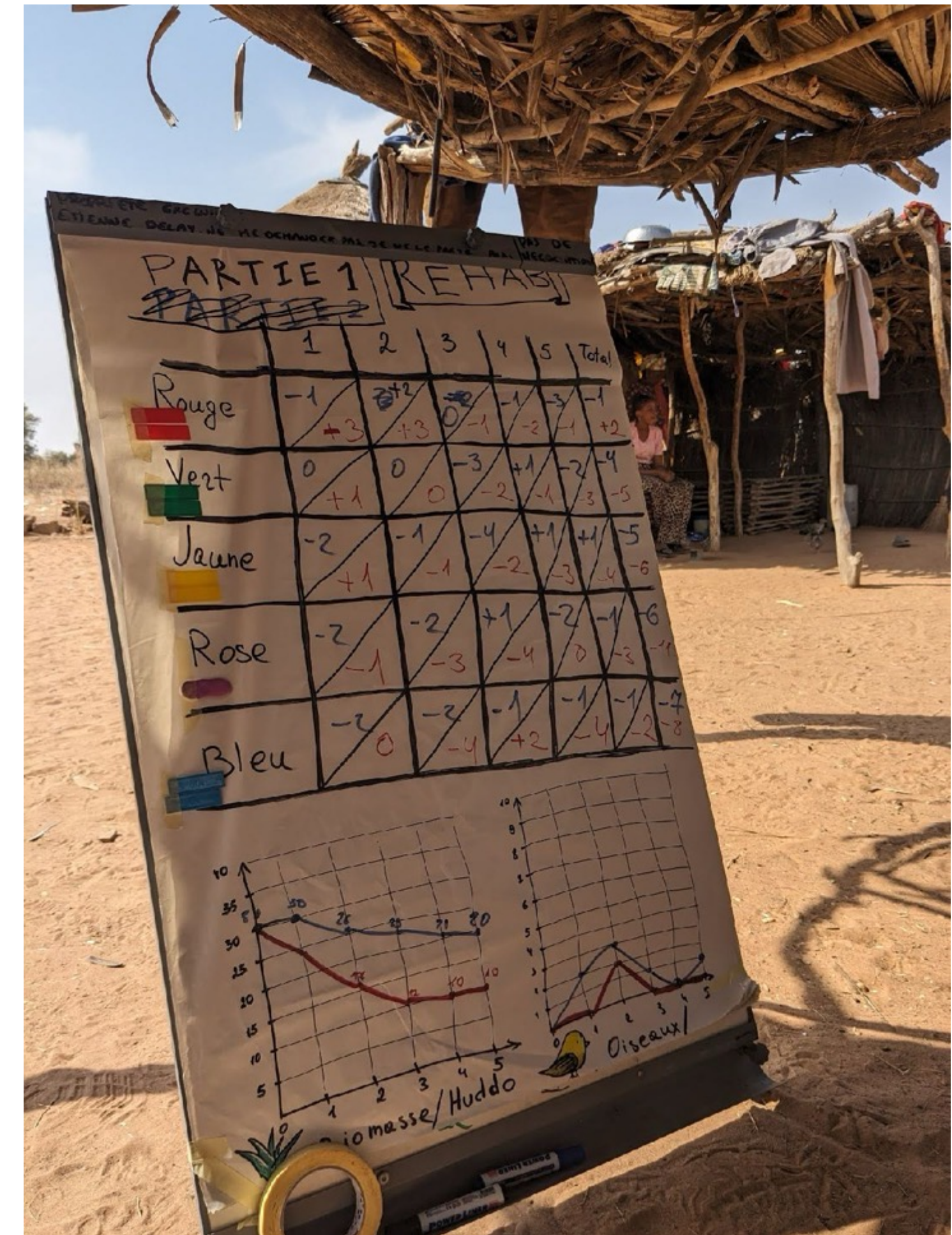
# Example of game: Planet C



"Because there is no Planet B"



Oleksandr Zaitsev © Cirad



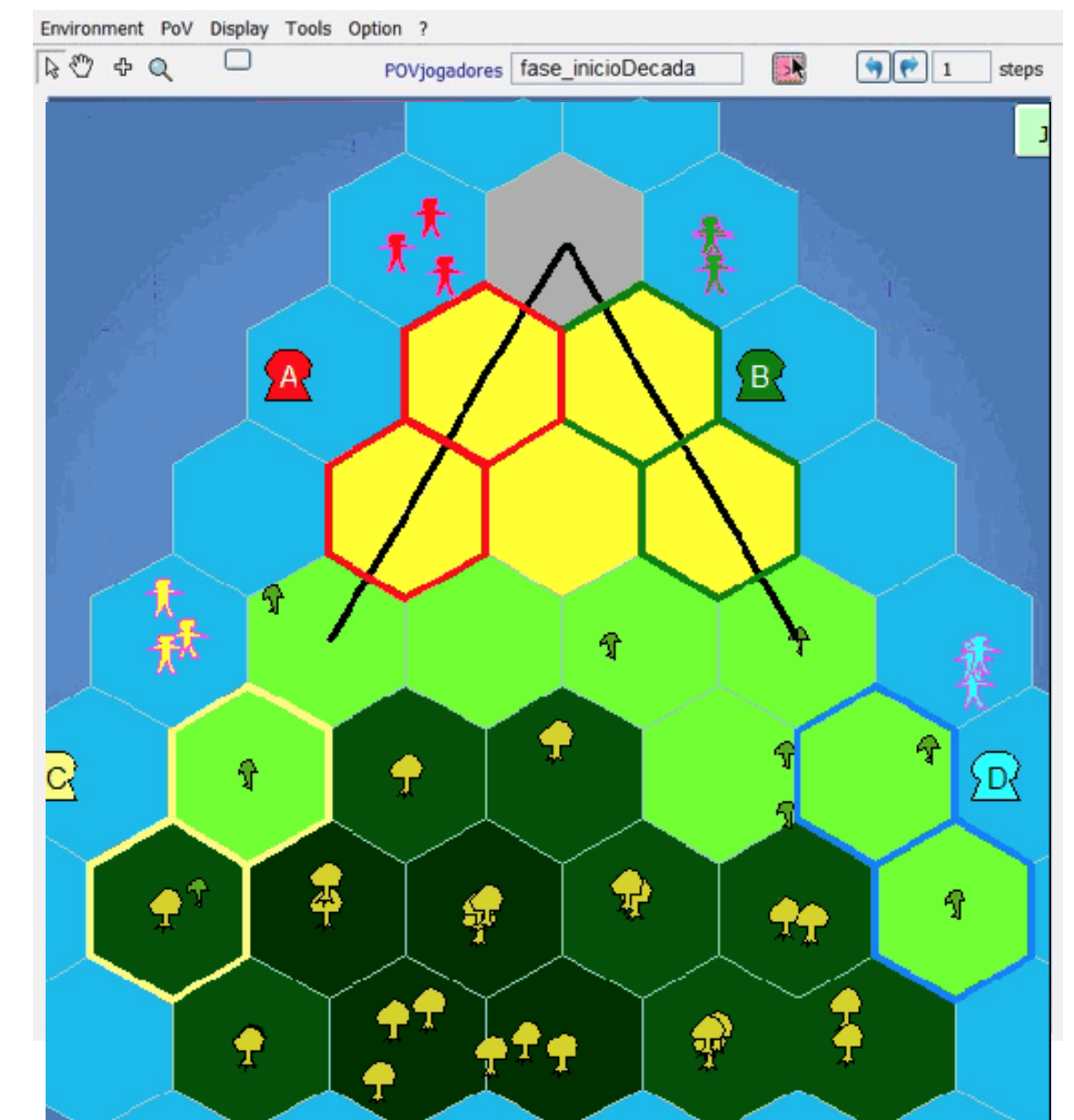
Oleksandr Zaitsev © Cirad



# Example of game: Dukunú Molê



Loose translation from Fôro Creole: « Save forest or die »



Pure board game or Computerized board game

The Cormas grid

A serious game developed in São Tomé and Príncipe to better manage the forest and, consequently, the unique biodiversity existing in this archipelago.



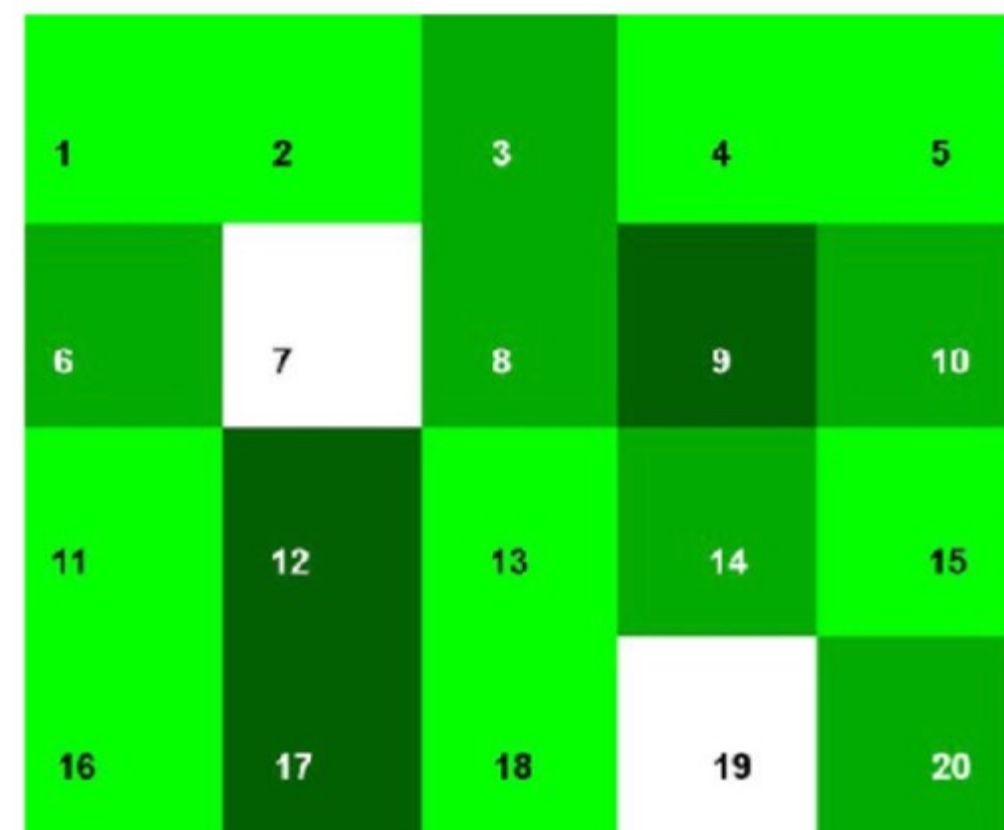
# Software Support for RPGs



The more complex is the game, the harder it is to manage. Facilitators have to remember all the rules and quickly update the environment in response to players' actions

## Help Facilitators

Facilitators use a software tool to perform calculations  
Players don't see the tool



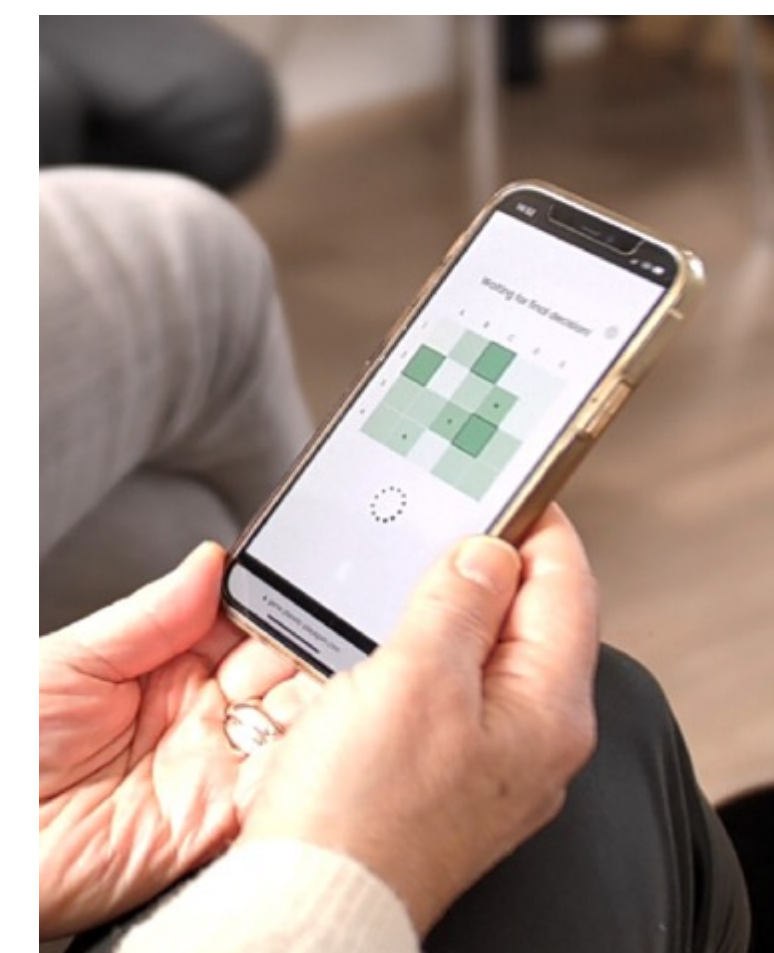
## Update the Environment

The tool calculates the new environment and outputs it on a surface



## Full Automation

The tool can take input from players, produce output and manage the game on its own





# Models as catalysts to favor the commoning



– “Kictec”: Keep it a Catalyst Tool to Empower Communities

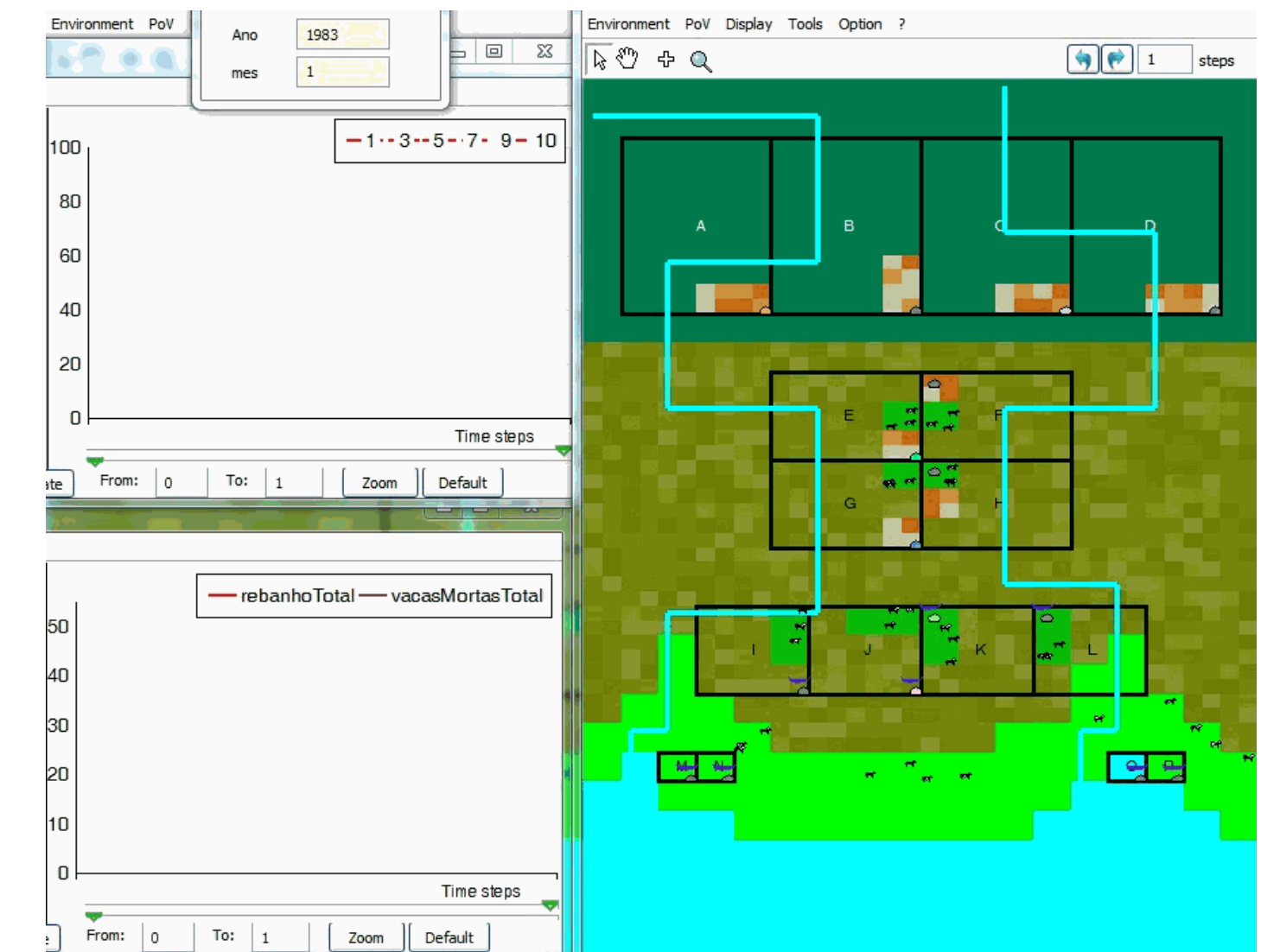
100% human RPG



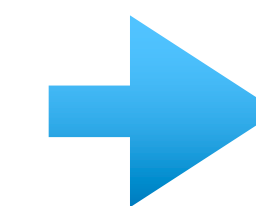
... Intermediate ...



100% computerized ABM



Debriefing: the most important phase



Empower citizens to be the actors of their own social transformation



A close-up, slightly blurred photograph of a field of golden wheat. The stalks are tall and thin, with small, light-colored heads. The background is a soft-focus expanse of more wheat. A white rectangular text box is overlaid on the left side of the image, containing the text 'Part 5: Computer Science Challenges'.

**Part 5:**

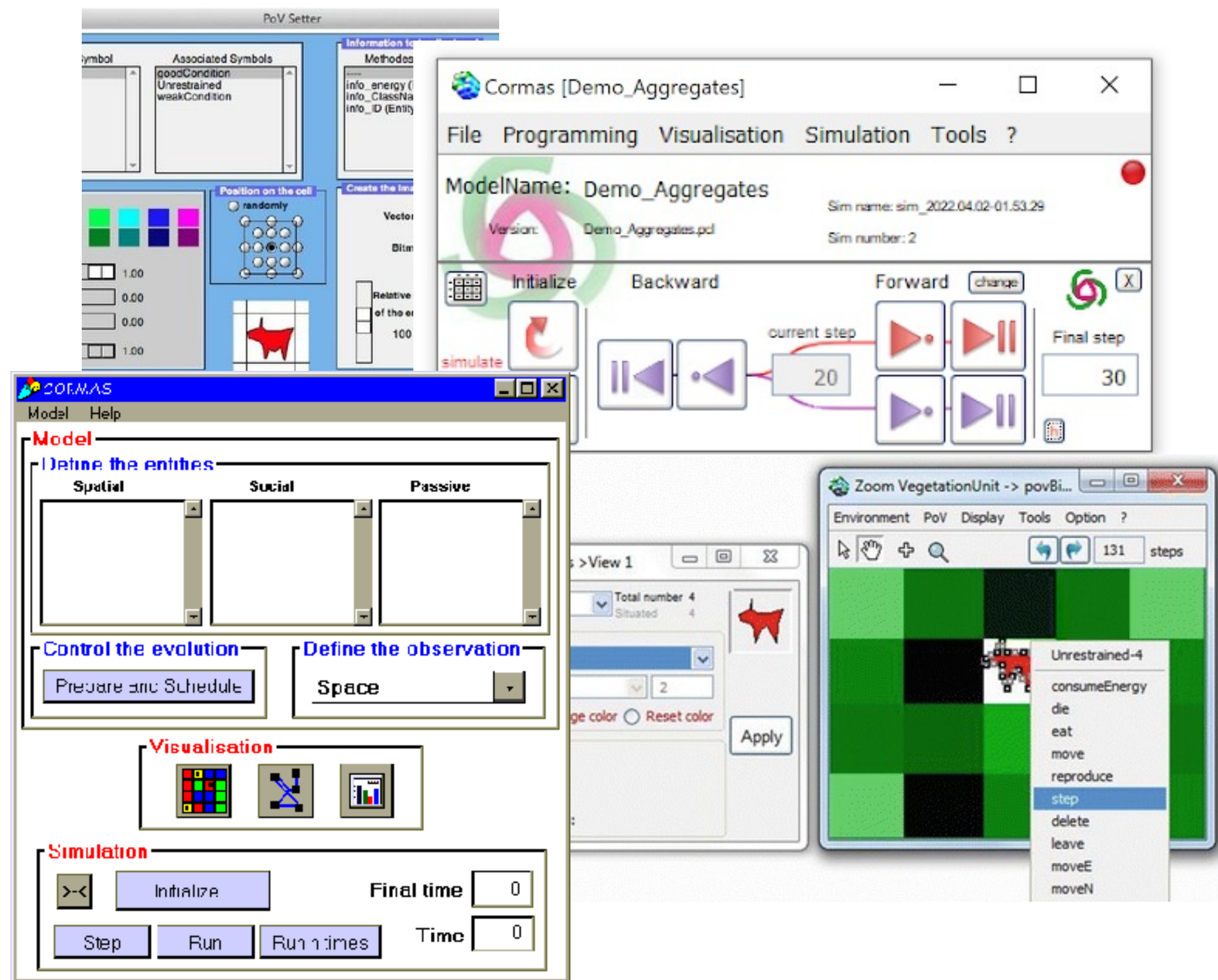
**Computer Science  
Challenges**



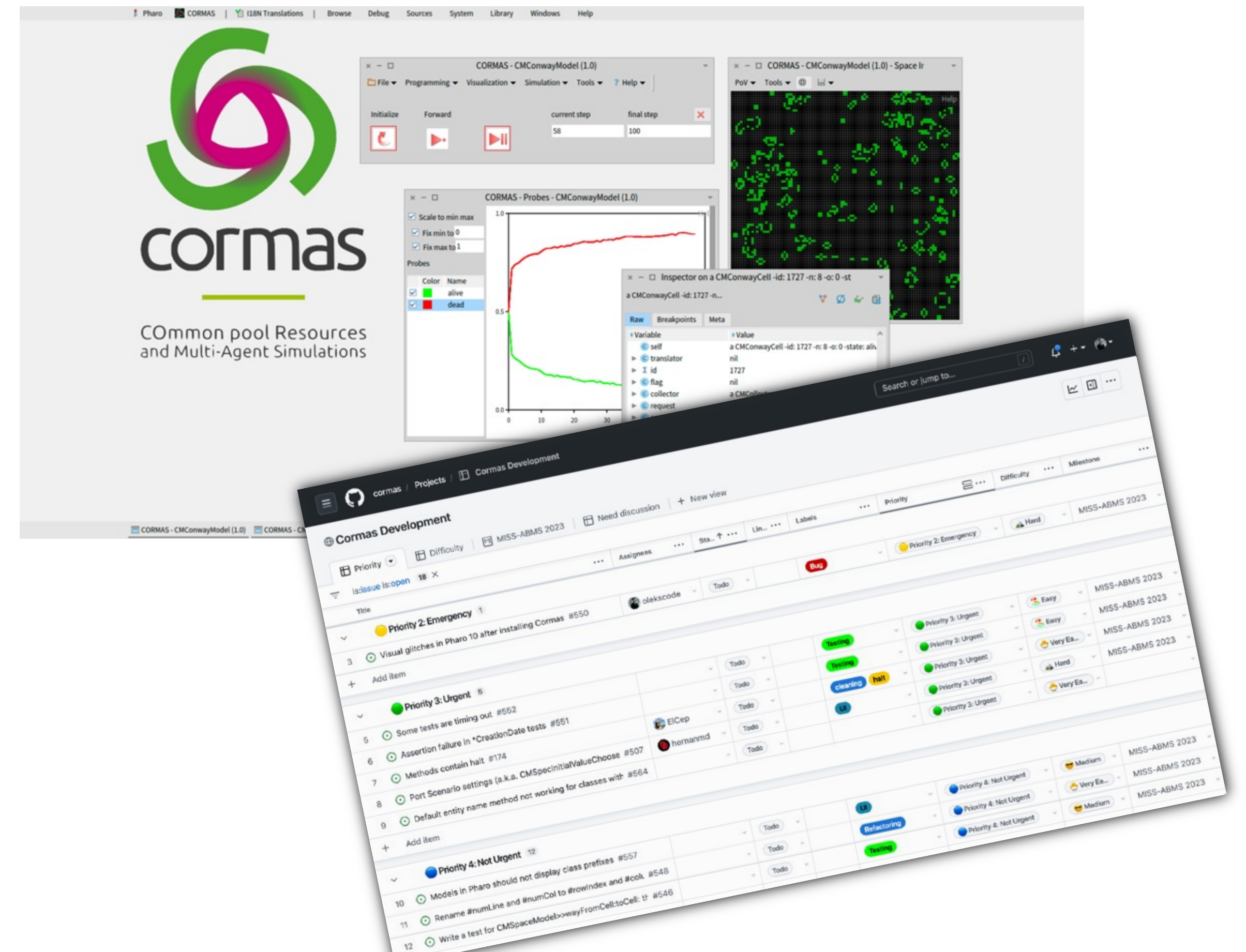
# Migrating from VW to Pharo



## Visual Works Cormas (discontinued)



## Pharo Cormas

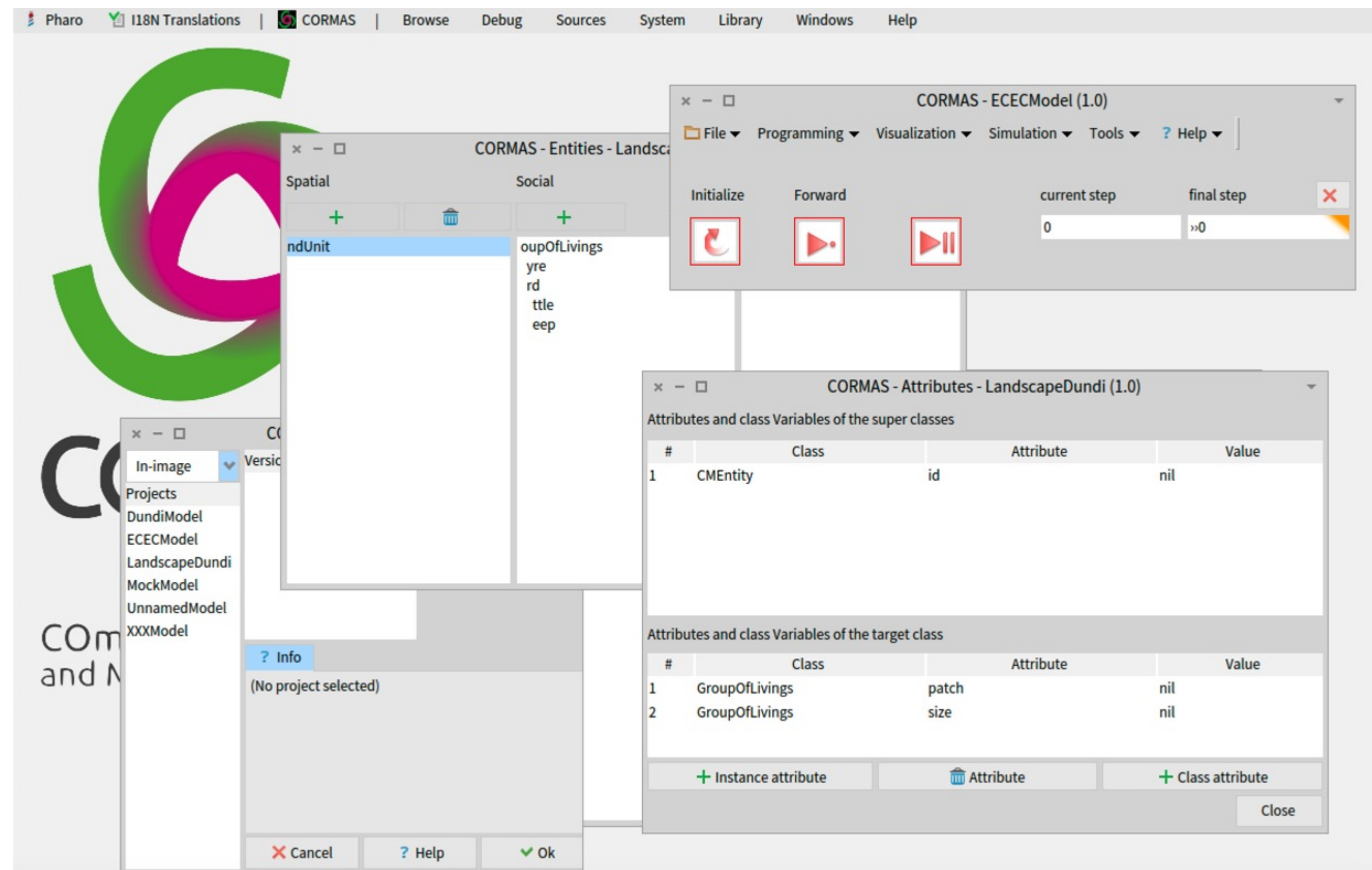




# Migrating Cormas to Pharo12



Currently we use Pharo 9 (deprecated distribution)



(a) Migrate Spec 1 to Spec 2

(b) Decouple Spec from Roassal and from Core

(c) Improve the UI

- ▶ Hernan's ideas
- ▶ Re:Mobidyc

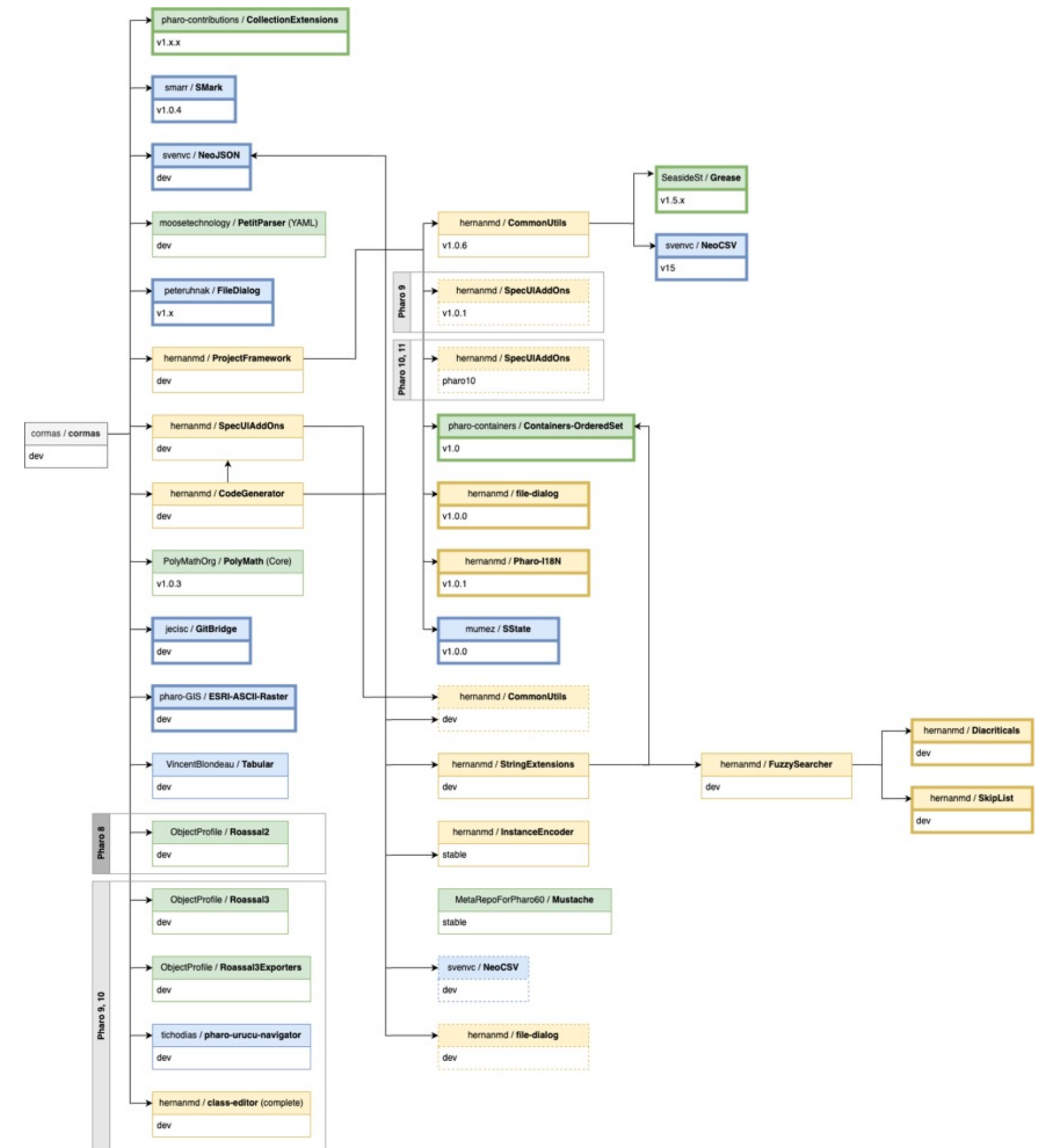


# Reducing External Dependencies



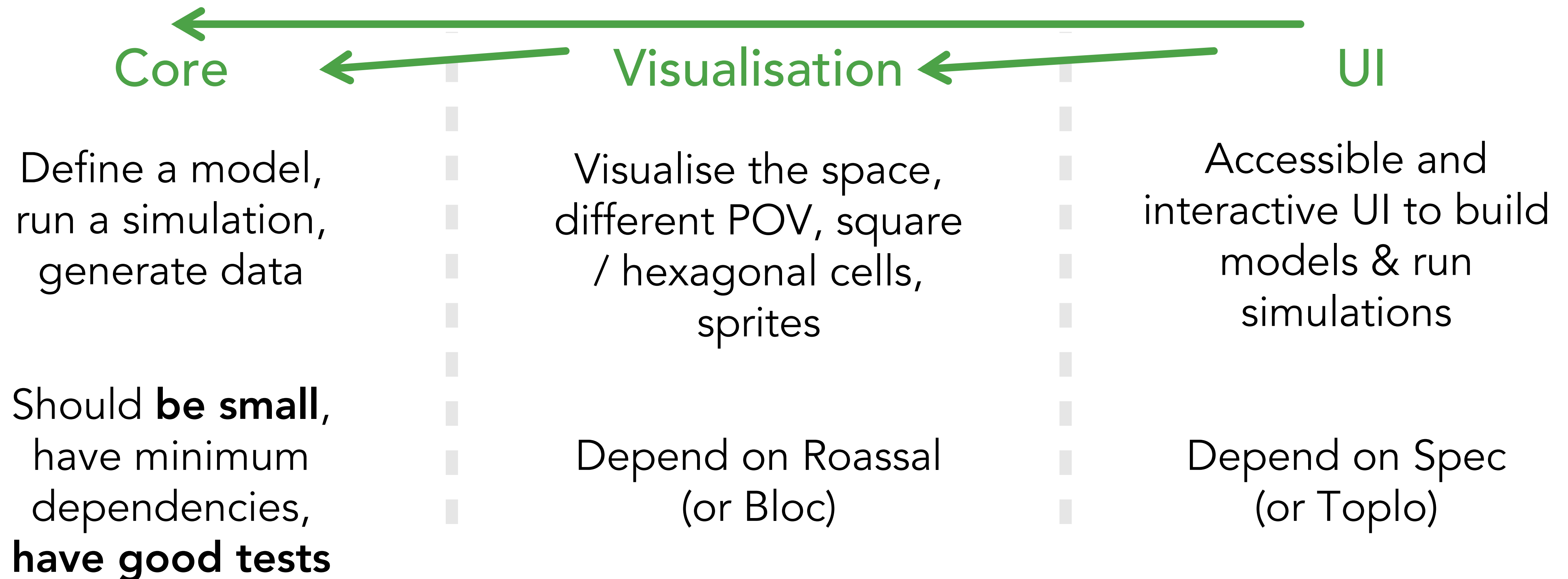
*Simple things should be simple*

- ProjectFramework 🙄
- Tabular
- SpecUIAddOns
- CodeGenerator
- pharo-urucu-navigator
- class-editor
- SState
- Grease
- Pharo-I18N
- PetitParser
- Roassal2
- Mustache
- StringExtensions
- FuzzySearcher
- NeoCSV
- NeoJSON
- InstanceEncoder
- PolyMath





# Decoupling and Testing

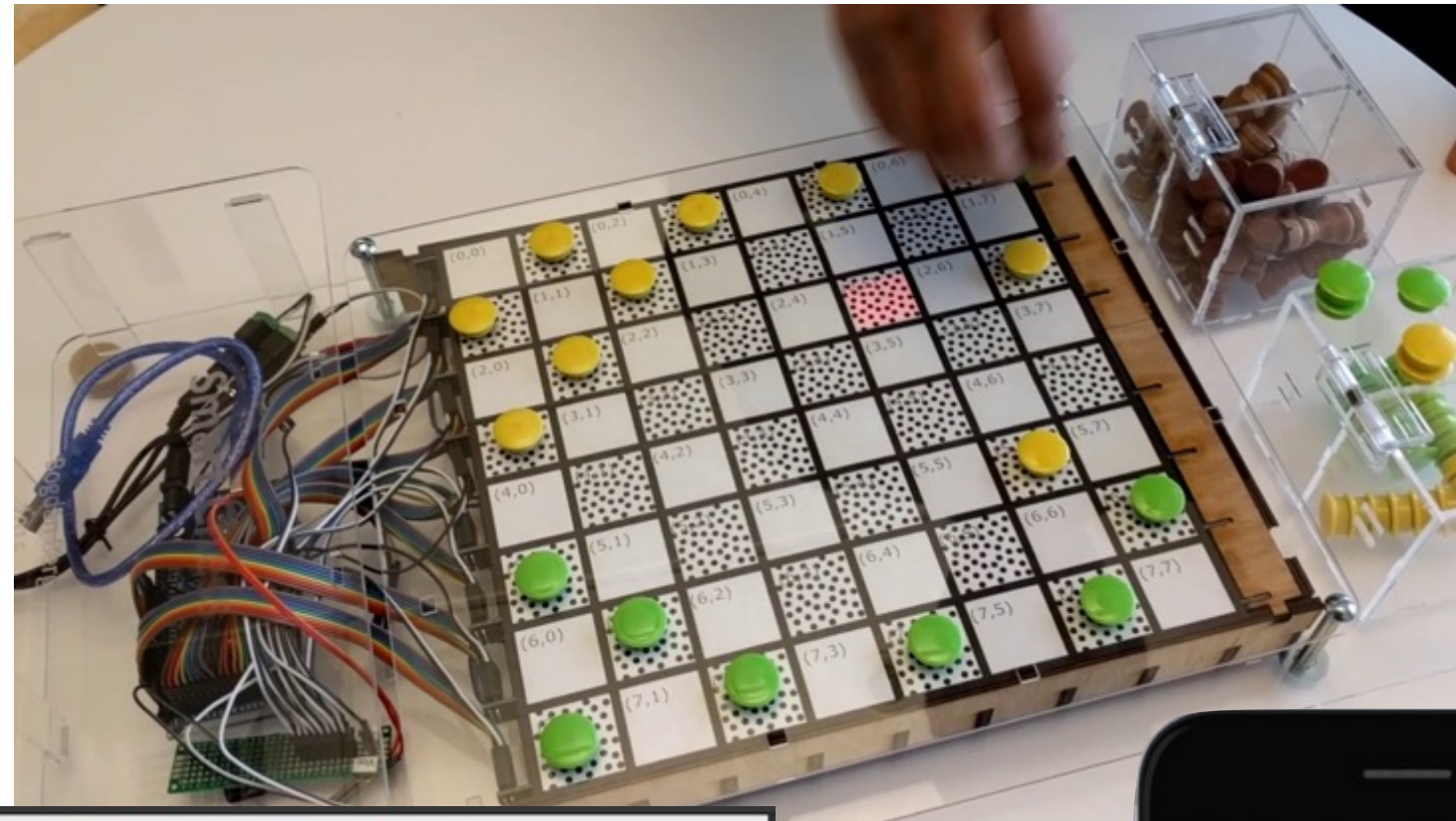




# Support Games



*Games are also ABMs where players are agents*



Every model is potentially a game



Every game is necessarily a model



# Smart Game Board for Planet C



*Players interact with computer simulation by moving pieces on a board*



Figure 1 : les tag RFID disposé sur le plateau



Figure 2 : le plateau de jeu avec ses tags et le Raspberry connecté au scanner (qui lui est caché sous la main)

Hybrid game board that combines interactivity of board games with the power of computer simulations

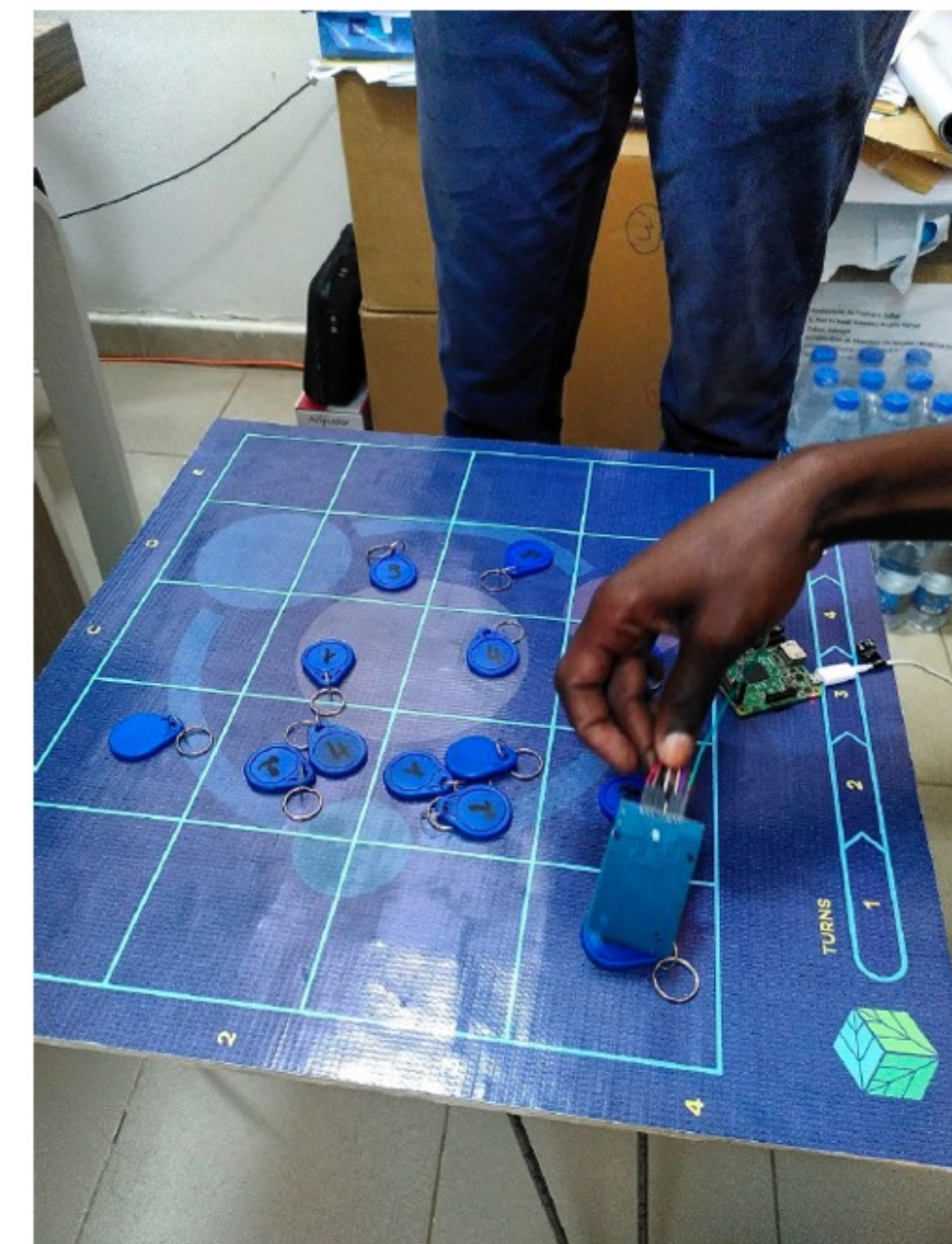


Figure 3 : les tags sont détectés par le scanner sur le plateau de jeu

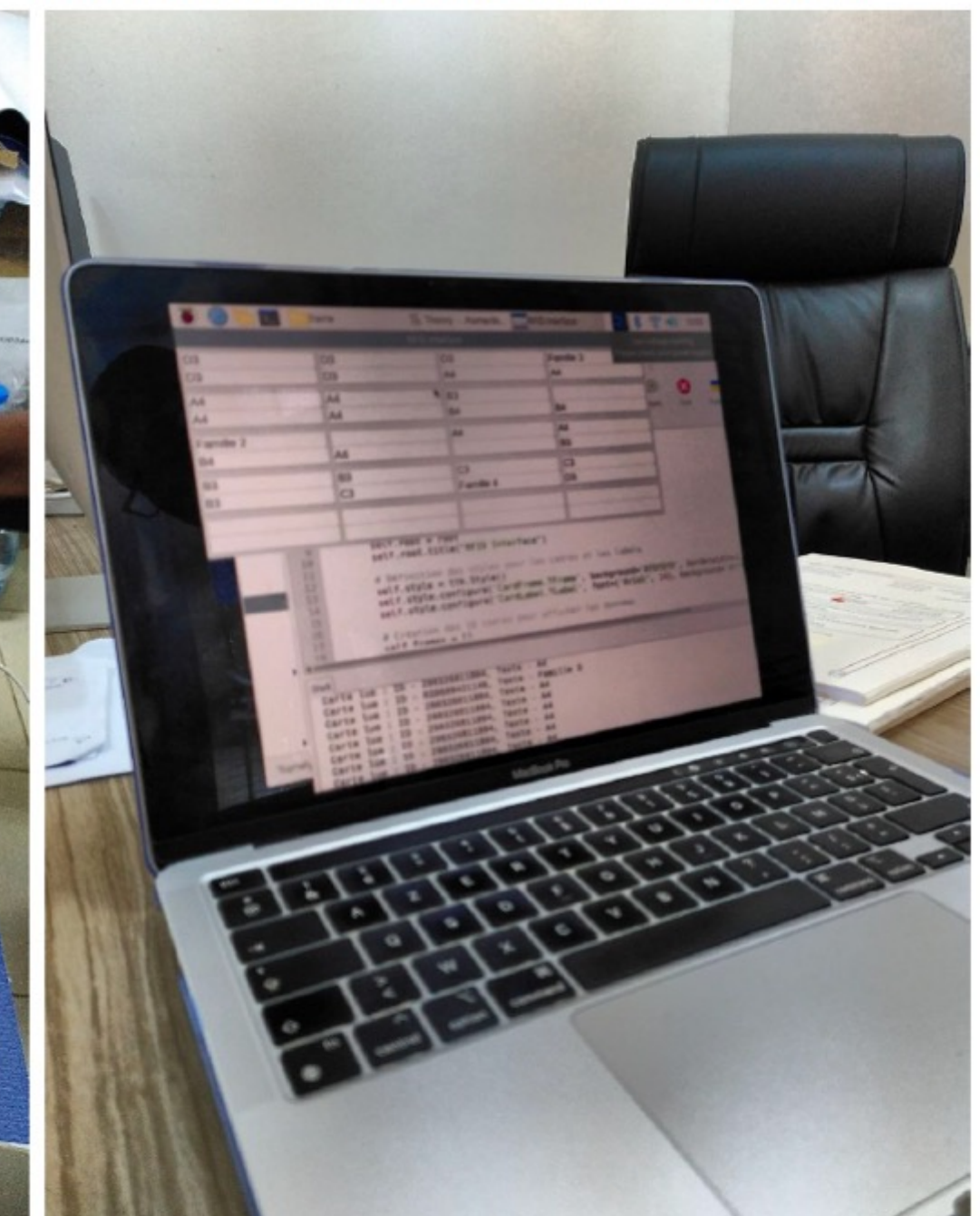


Figure 4 : Les éléments sont affichés sur l'interface en python du raspberry auquel l'ordinateur est connecté via vnc

Developed by our colleagues from Cheikh Anti Drop University in Senegal (UCAD, ESP)



# Challenge: Debugging ABM



*Modellers may ask different debugging questions than other developers*

## Software Development

Developers have to explore large code bases with many dependencies

## Modelling

Models are usually small and their code is easy to understand

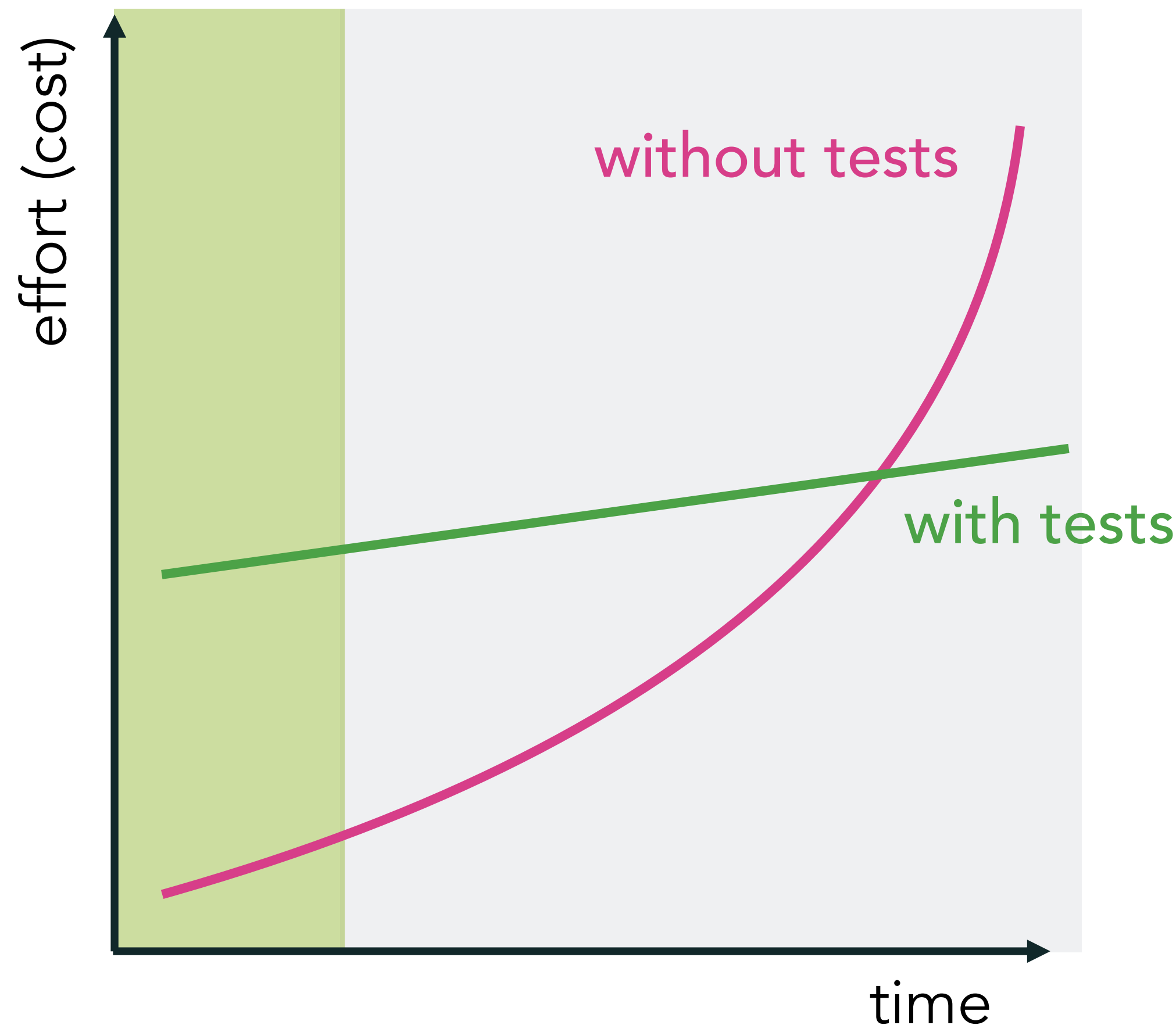
Have to deal with many live objects that have autonomous behaviour and can cause strange phenomena



# Challenge: Testing ABM



*Companion modelling requires quick coding and prototyping*



**Modelling phase**

In ComMod sessions, speed and simplicity are the key factors

**Post-modelling phase**

Published model must remain valid, reusable, and reproducible

**Q:** What is the testing workflow for ABM that would not interfere with ComMod practices?



# Summary



## Development

- Migrate Spec 1 —> Spec 2
- Migrate to Pharo 12
- Reduce unwanted dependencies
- Reduce coupling
- Good test coverage (and good tests!)
- Bring all the missing features from VW

## Innovation

- Propose a metamodel to support:
  - Companion modelling
  - Games
  - Resource management
- Debugging ABM
- Testing practices for companion modelling (e.g. generated tests)



## Get in touch



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CIRAD, UMR SENS

## Follow Cormas

<https://mastodon.social/@cormas>

<https://github.com/cormas/cormas>

<https://cormas.cirad.fr/> (old)

## Work with us

- Google Summer of Code
- Pharo Summer School & ESUG conference
- Internships at Montpellier and Lille
- Apprenticeship (master education + paid work)
- PhD and Postdoc

## Learn Pharo

<https://mooc.pharo.org/>

<https://advanced-design-mooc.pharo.org/>

<https://books.pharo.org/>