

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 (Savoirs, ENvironnement, Sociétés = 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).





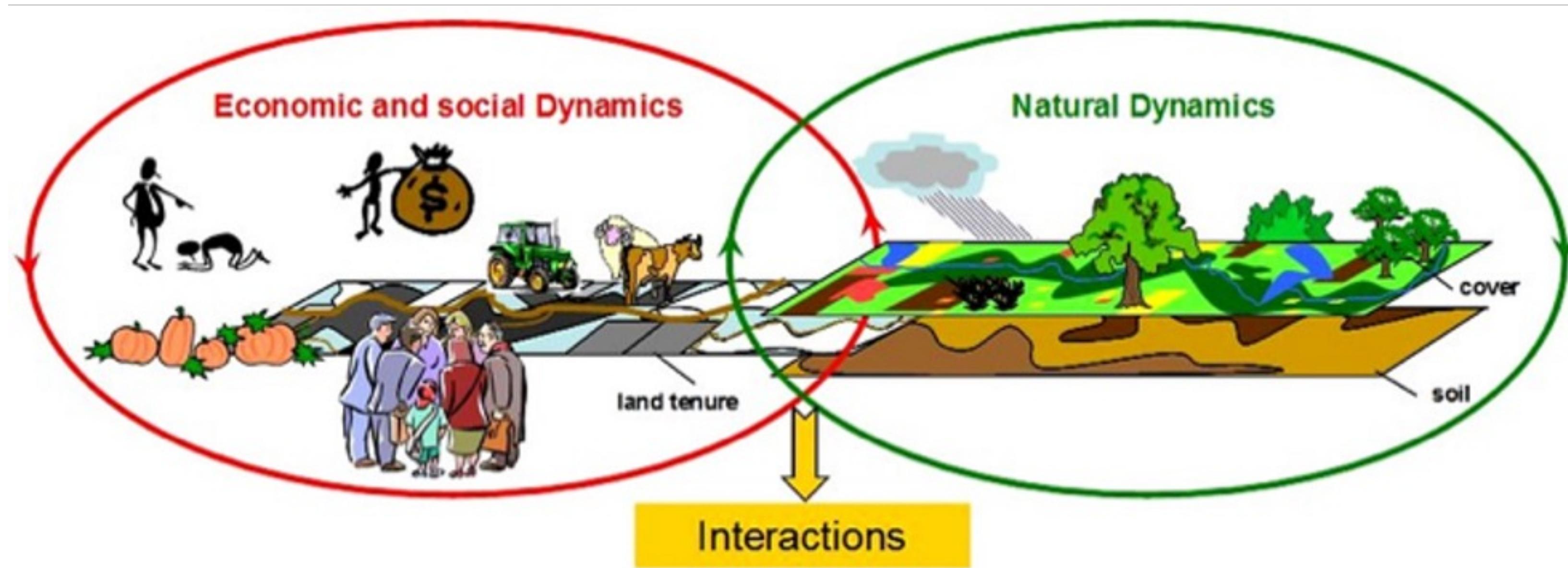
Part 1:

Agent-based modelling

ABM to simulate socio-eco-system

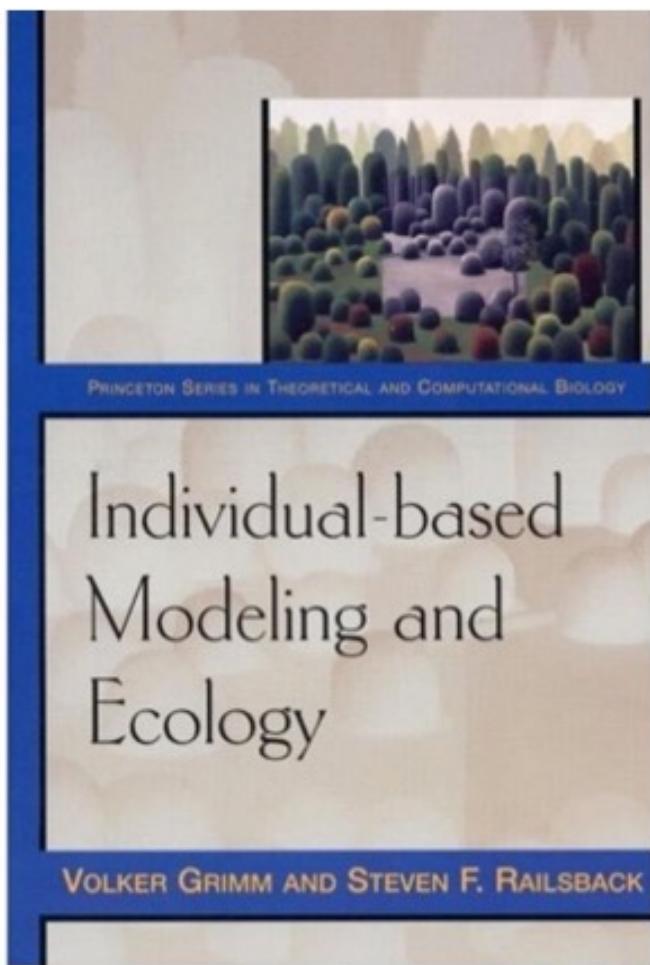
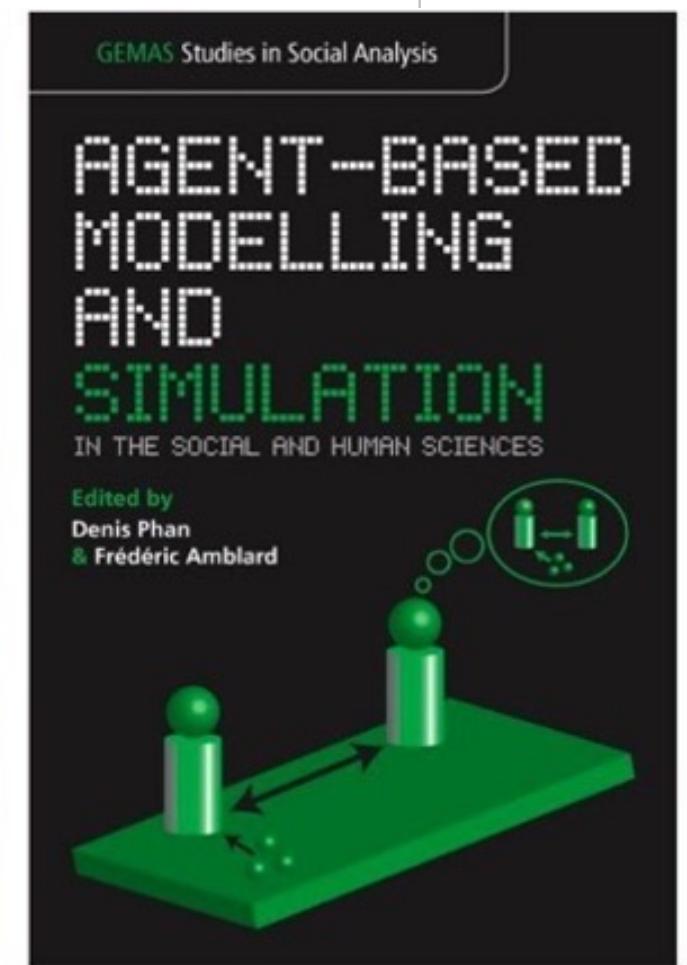
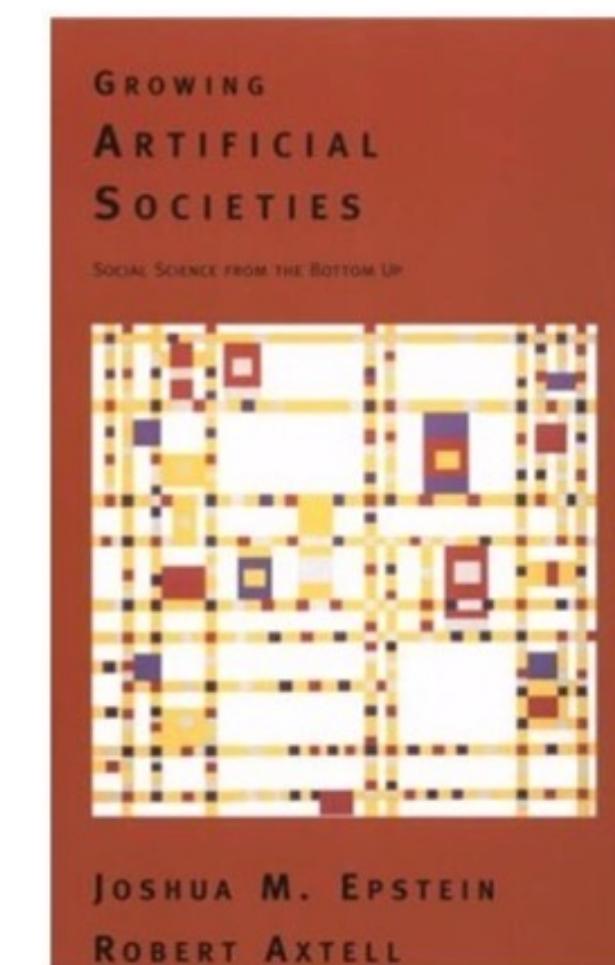


Crossing various dynamics



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



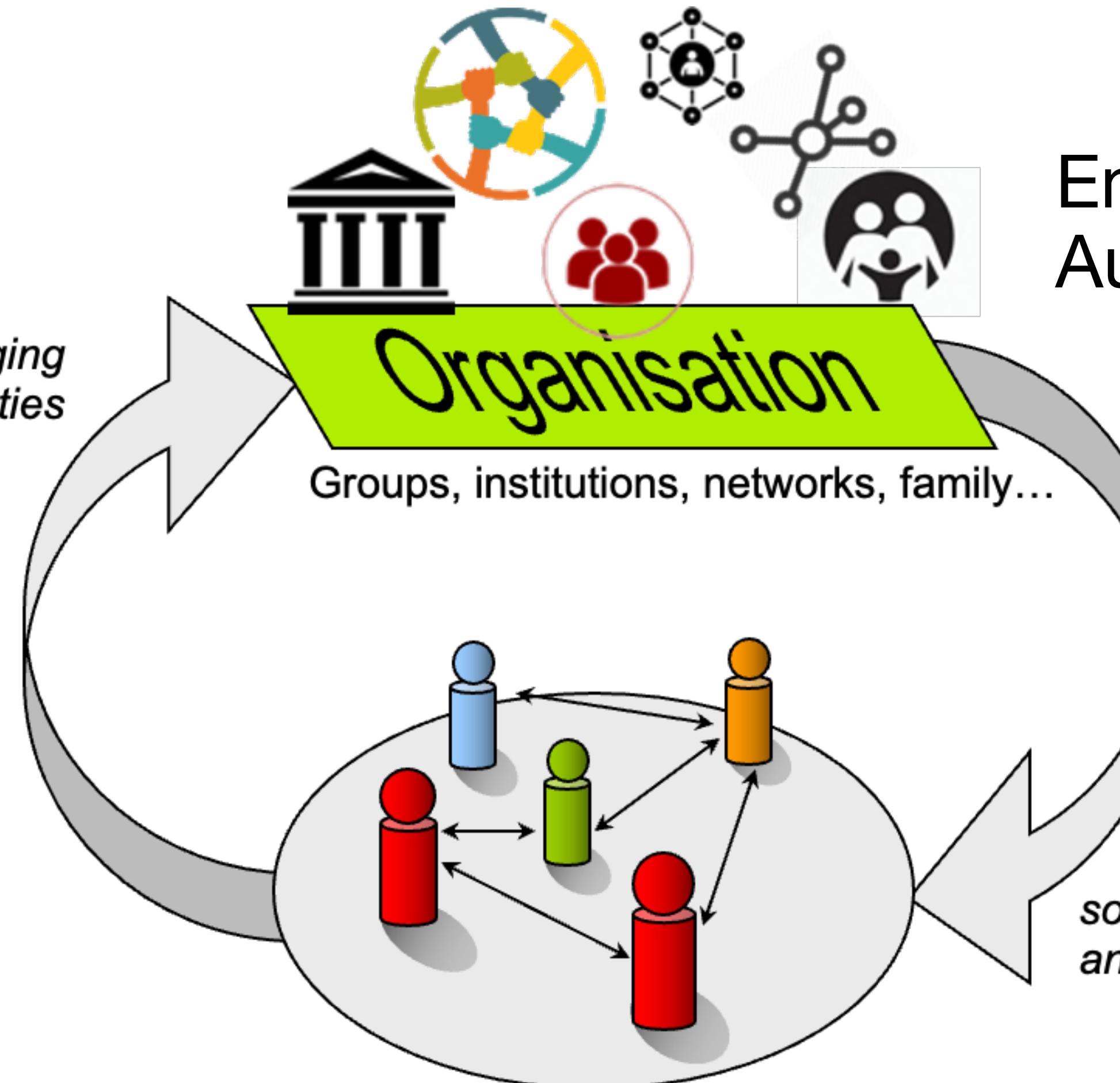
Methodological individualism
Raymond Boudon
Max Weber

Methodological holism
Emile Durkheim
Pierre Bourdieu

Reciprocal dependencies
Norbert Elias
Theory of structuration
Anthony Giddens

Macro level

emerging functionalities



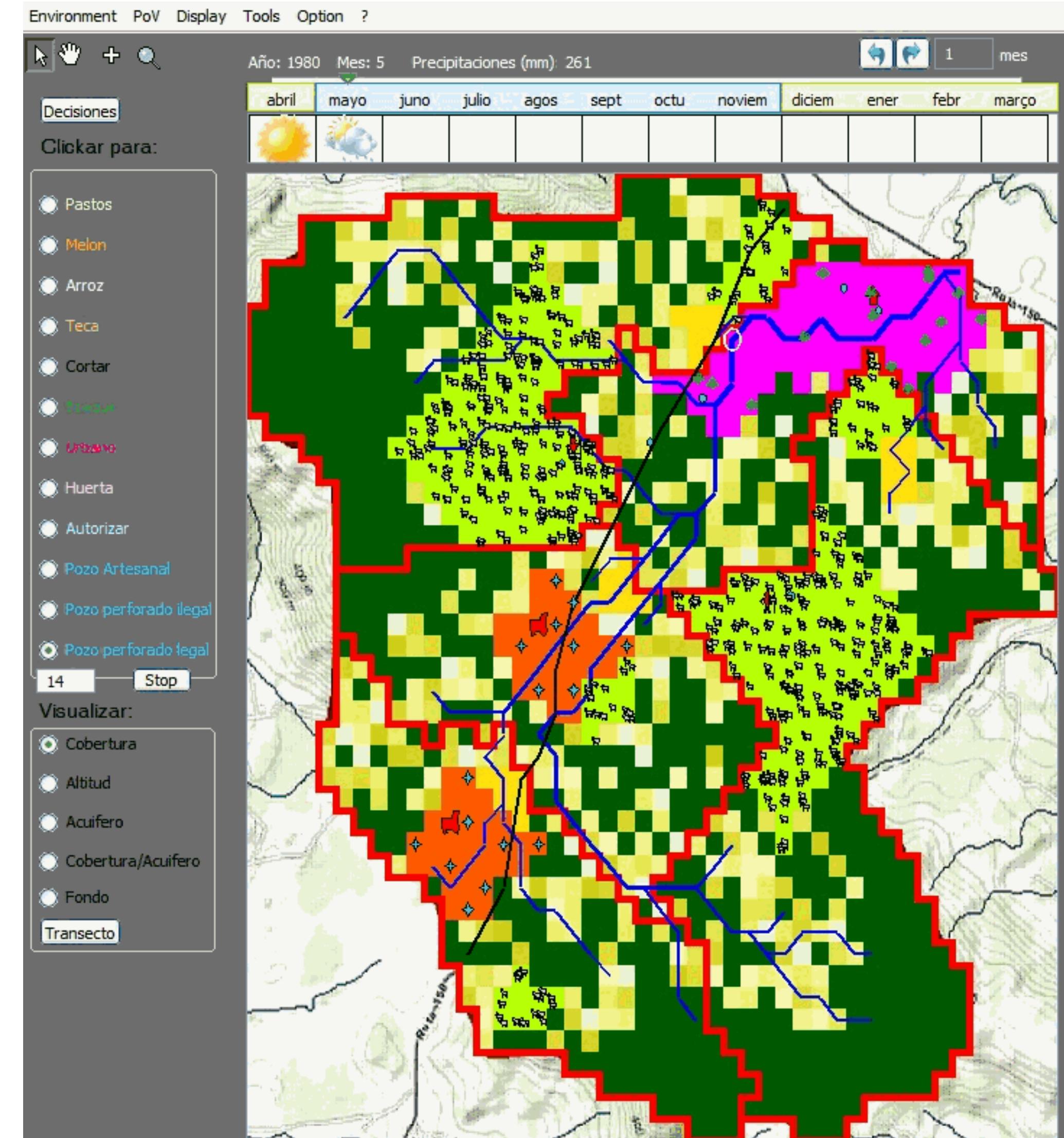
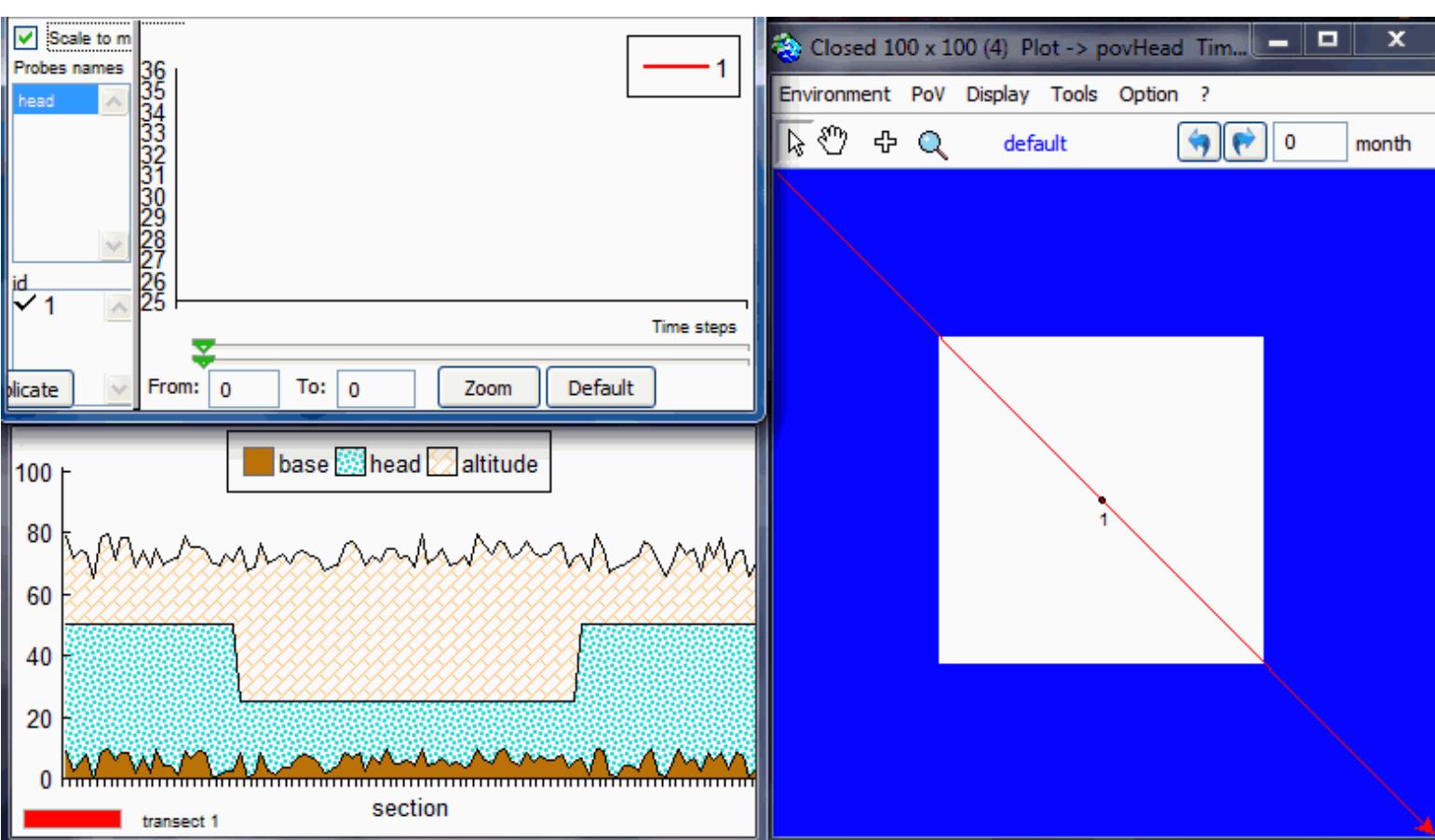
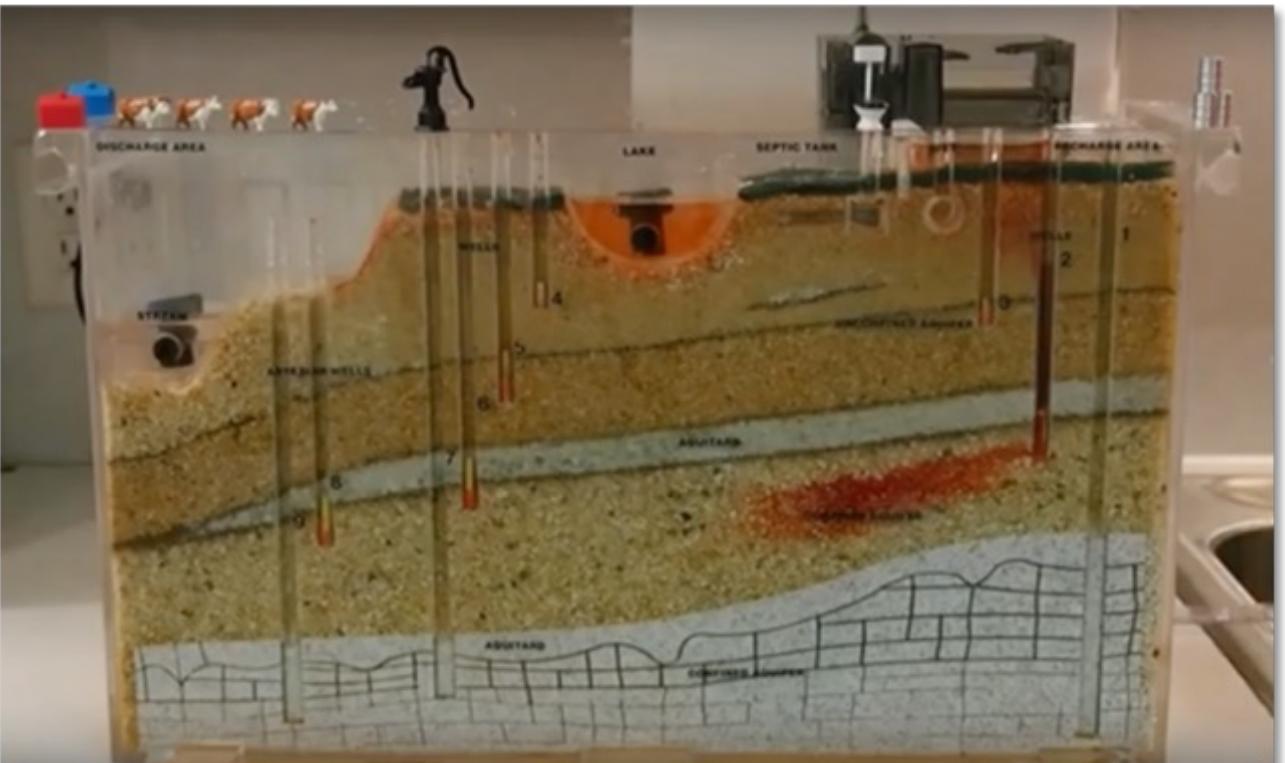
Micro level

Emergence,
Auto-organisation

ABM examples (Cormas VW)

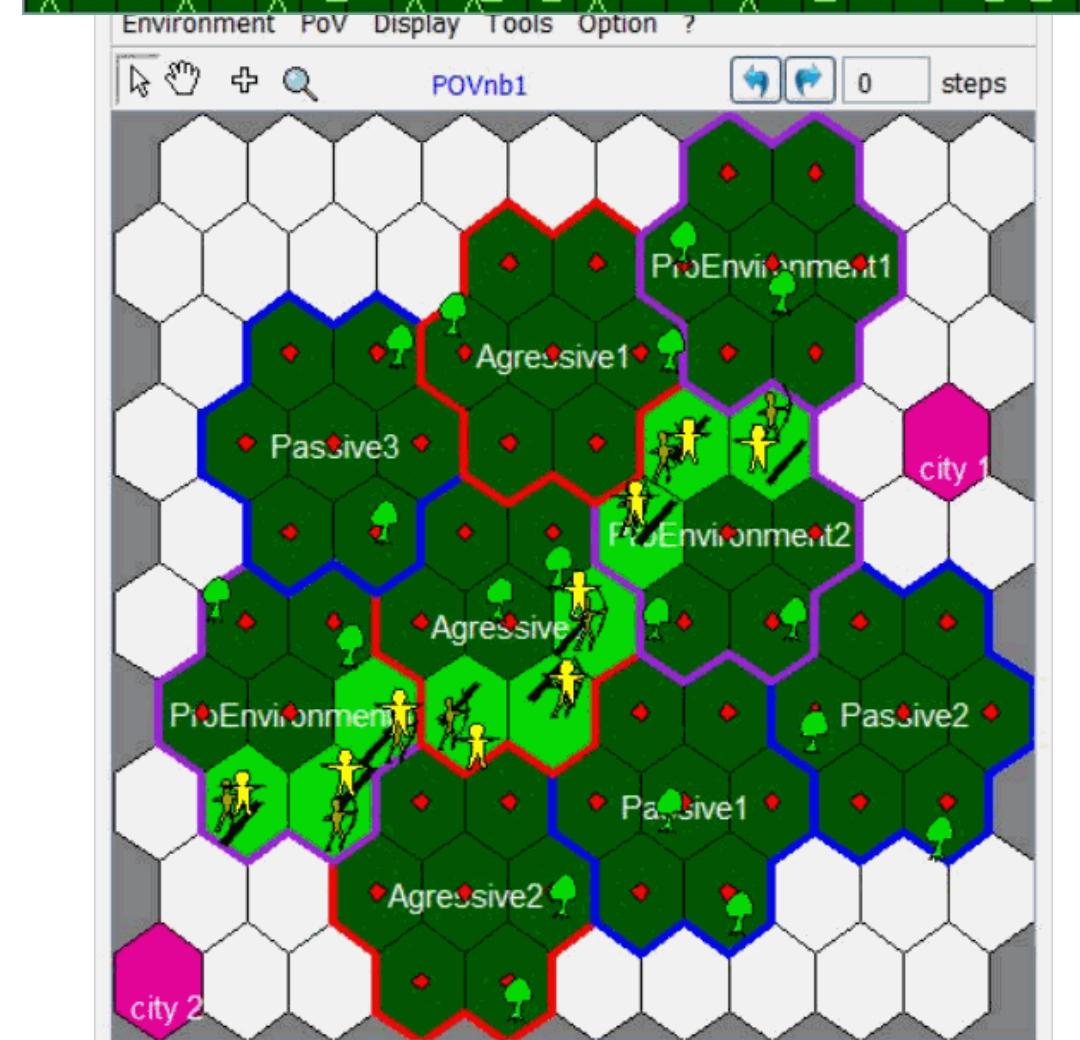
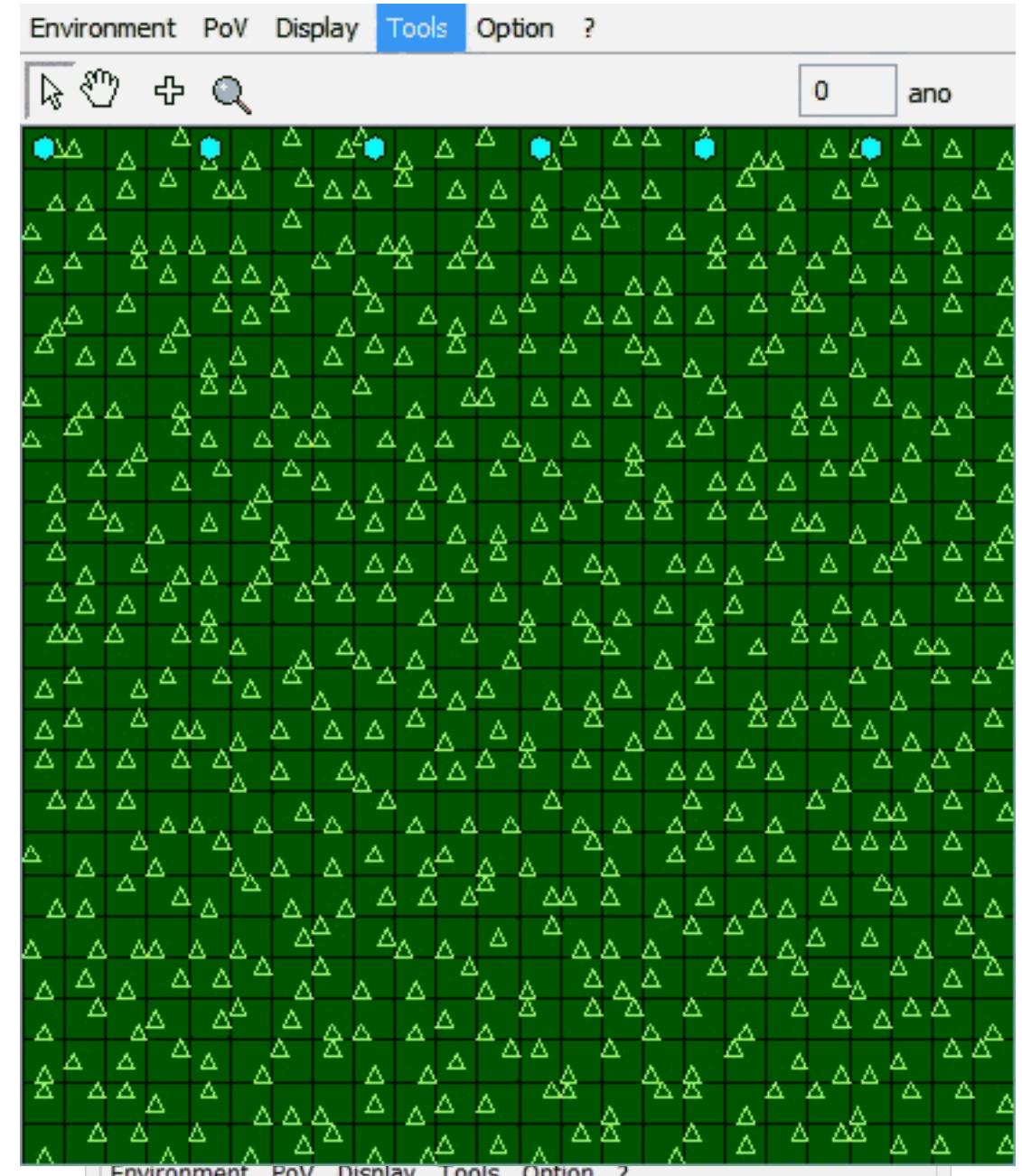
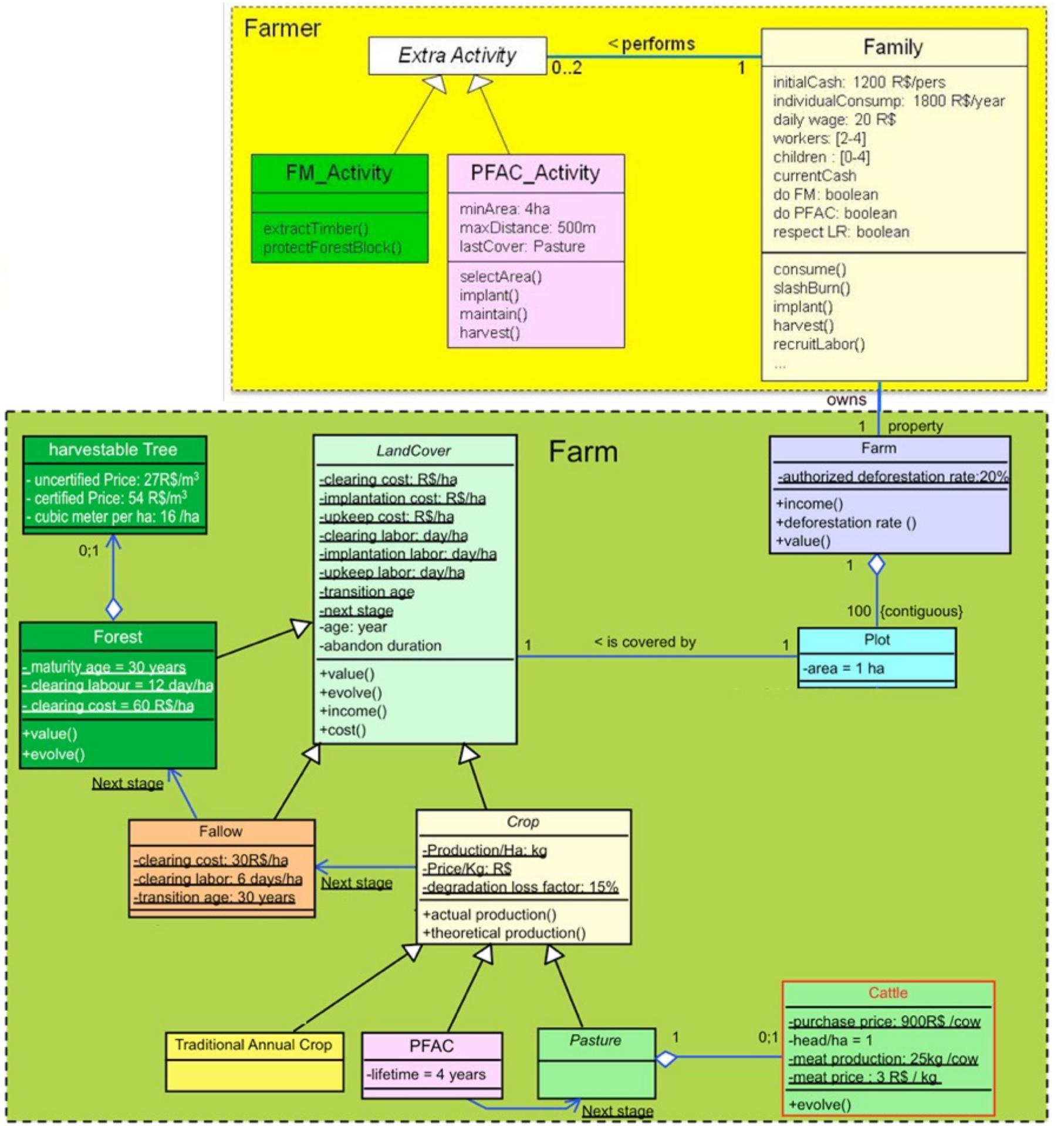
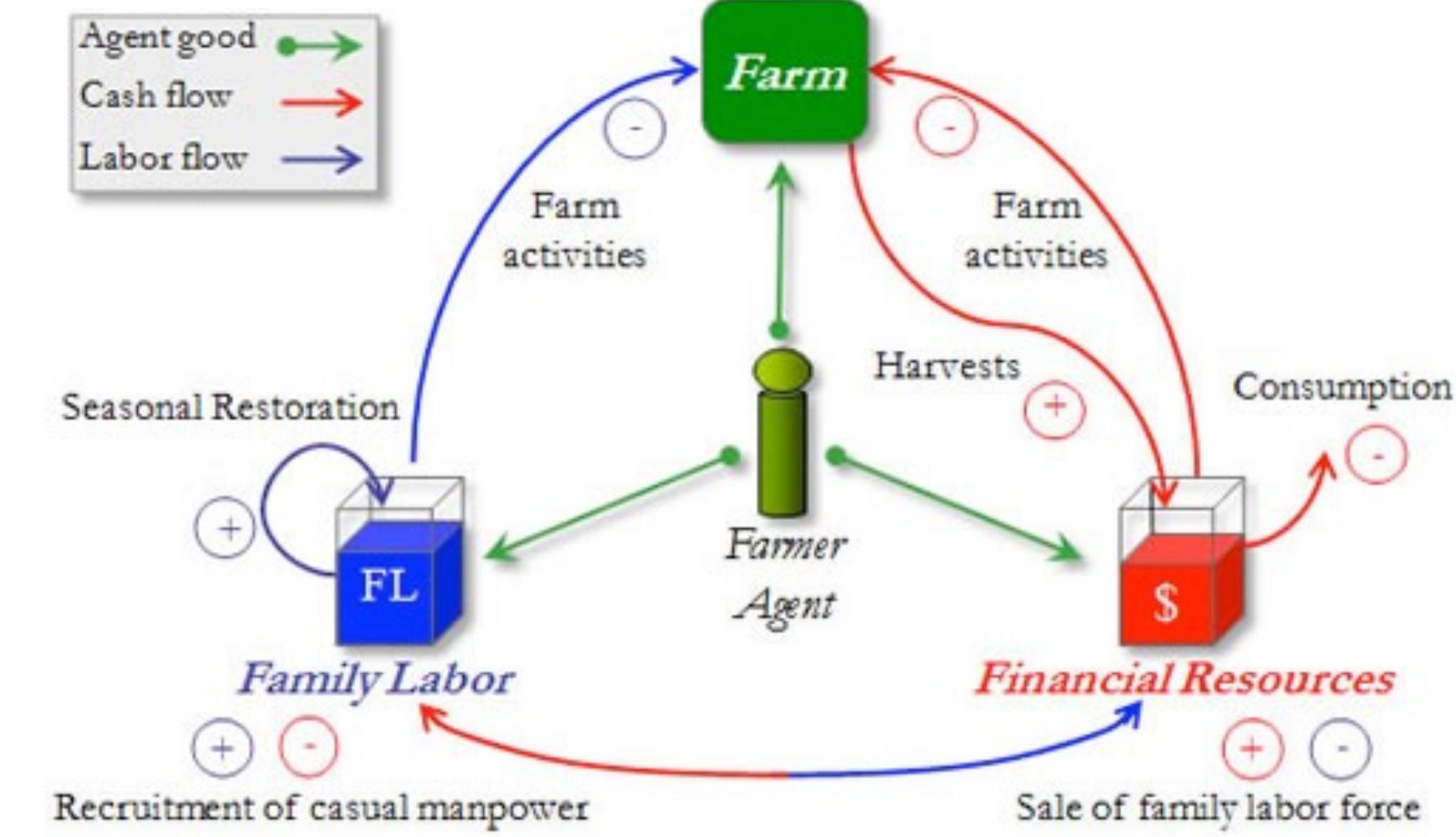


Groundwater pollution in Costa Rica



Example of ABM (Cormas VW)

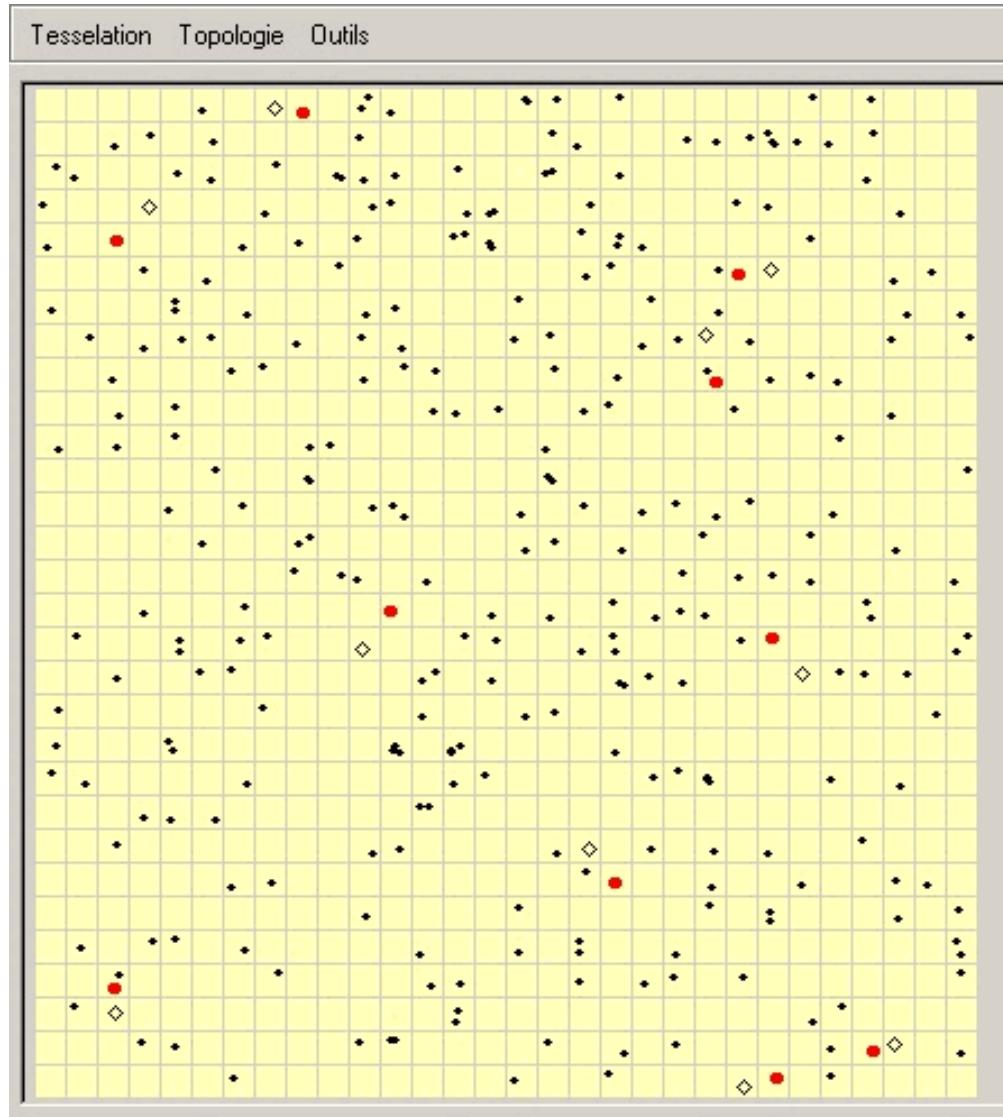
Alternative farming practices to deforestation in the Amazon



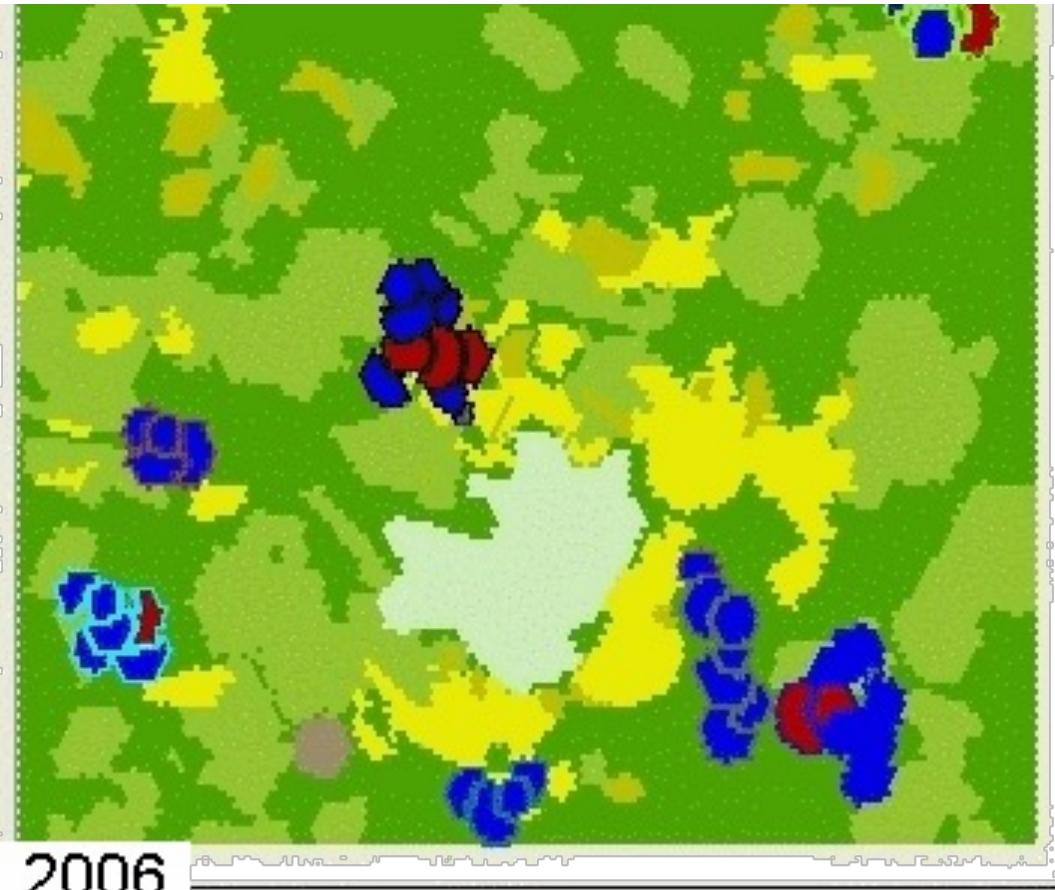
Example of ABM (Cormas VW)



Emergence of resource-sharing conventions



Savannah landscape mosaic under shifting cultivation, North Cameroon

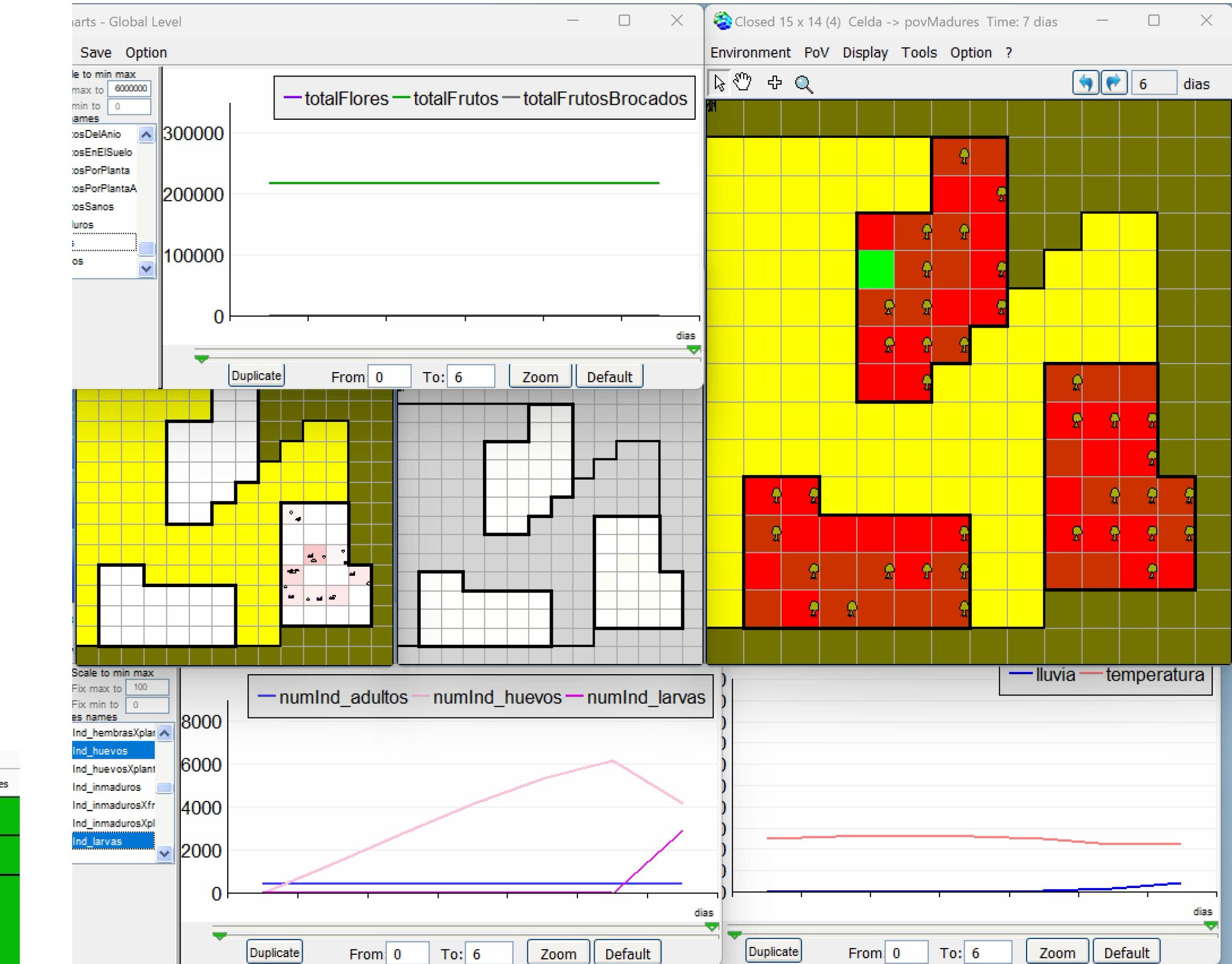


Coffee rust spread in Nicaragua

Network evolution



Network evolution



CBB spread in Central America

Unique Features of Cormas

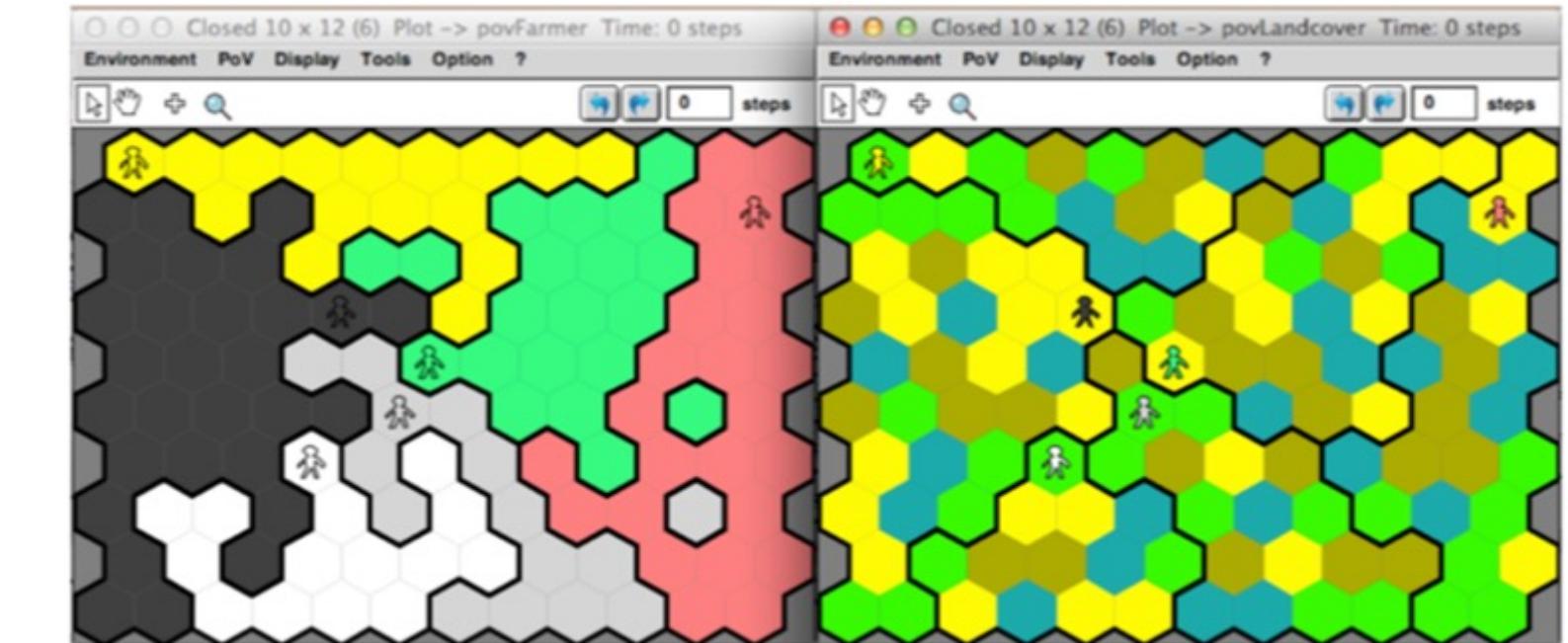


... that make it well-suited for companion modelling



Different « Points of View »

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



Live dynamic environment where everything is an object

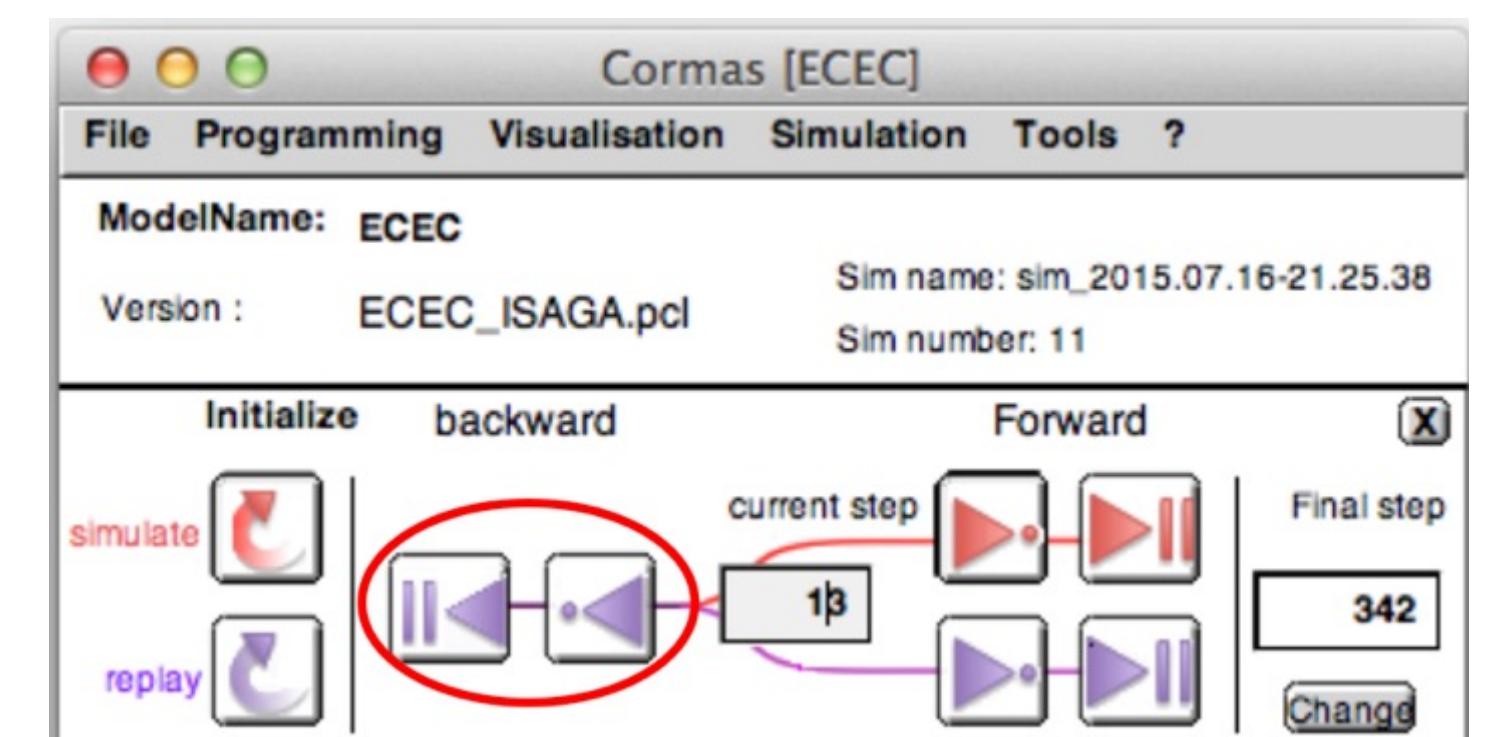


Interact with anything at any time without stopping the simulation



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**

The image displays three main components of the Cormas Platform:

- Book:** A screenshot of the book "Cormas : Building Agent Simulations With Pharo" by Etienne Delay, Pierre Bommel, Bruno Bonté, Nicolas Bonté, and Sébastien Lefèvre. The book cover features the Cormas logo and the subtitle "Simulations With Pharo".
- GitHub Repository:** A screenshot of the GitHub repository "cormas/cormas". The repository has 1.1k stars and 1.1k forks. It shows a list of files and a commit history.
- Jira Issue Tracker:** A screenshot of the Jira issue tracker for the "Cormas Development" project. The search bar shows "Priority 2: Emergency". The list includes several issues with labels like "Bug", "Priority 2: Emergency", and "Priority 3: Urgent". One issue is "Visual glitches in Pharo 10 after installing Cormas" (issue #550). Another issue is "Some tests are timing out" (issue #552).



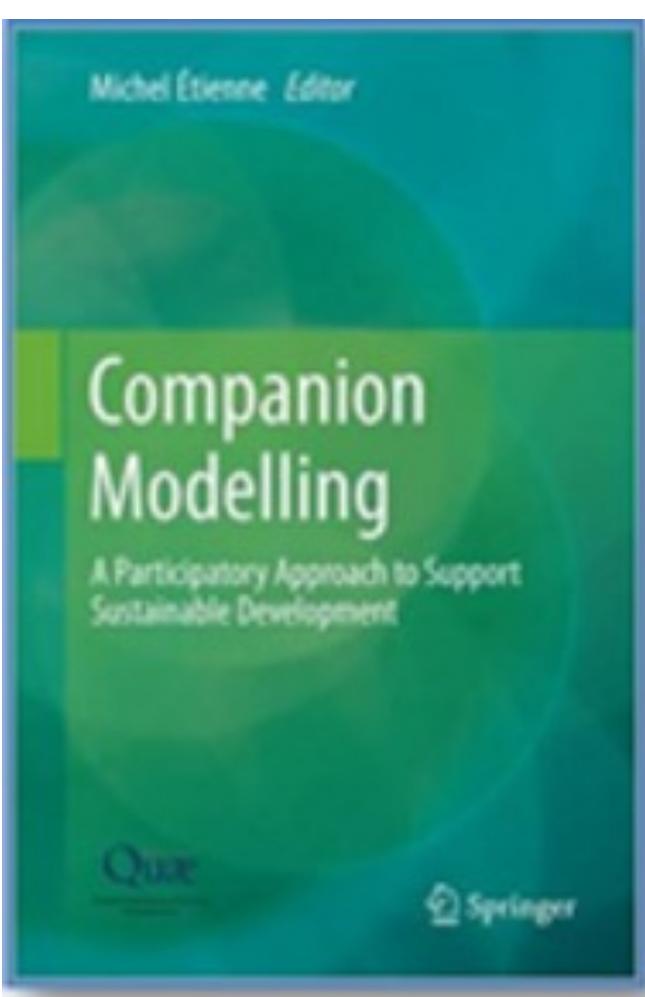
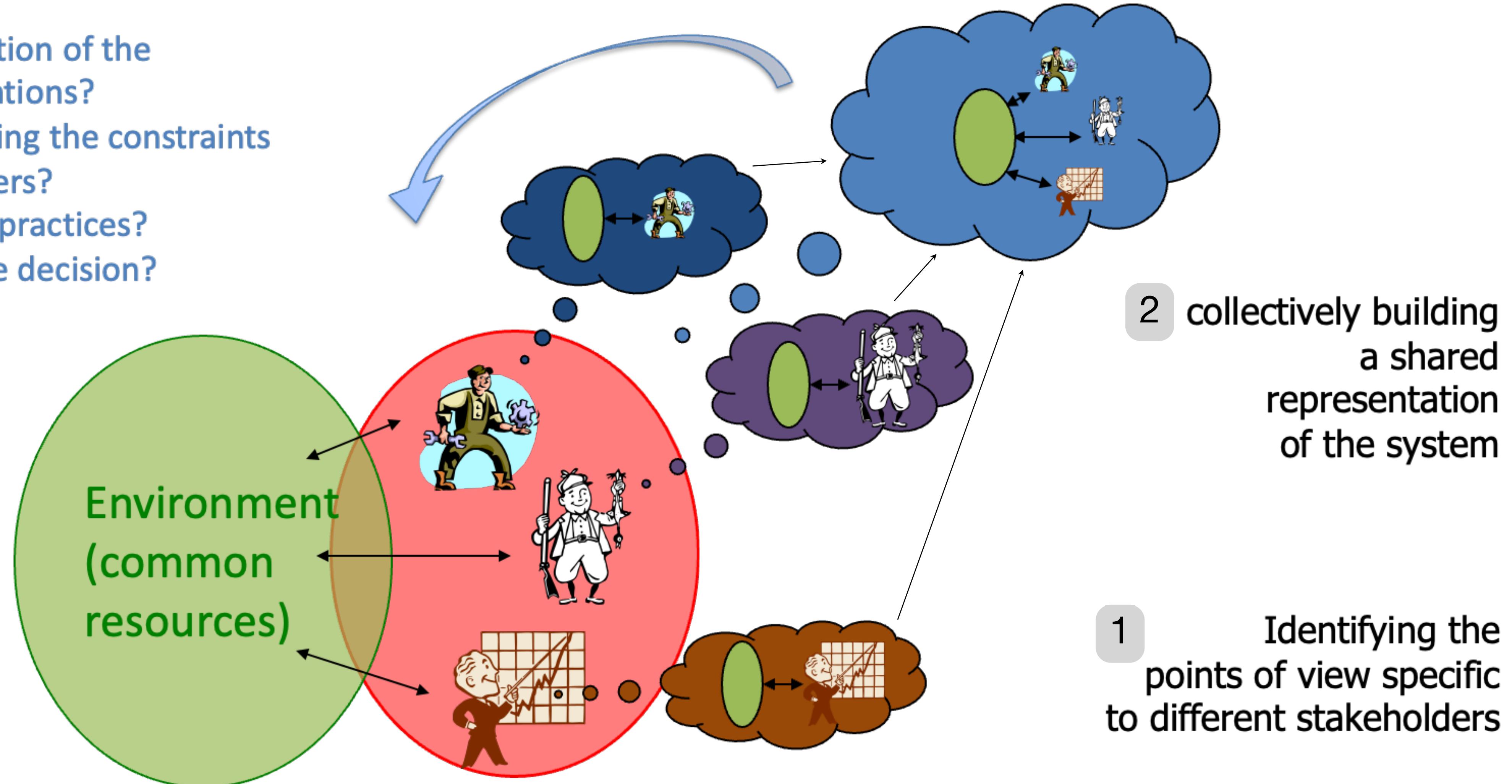
Part 3:

The Companion Modelling Approach

ComMod

Companion Modelling

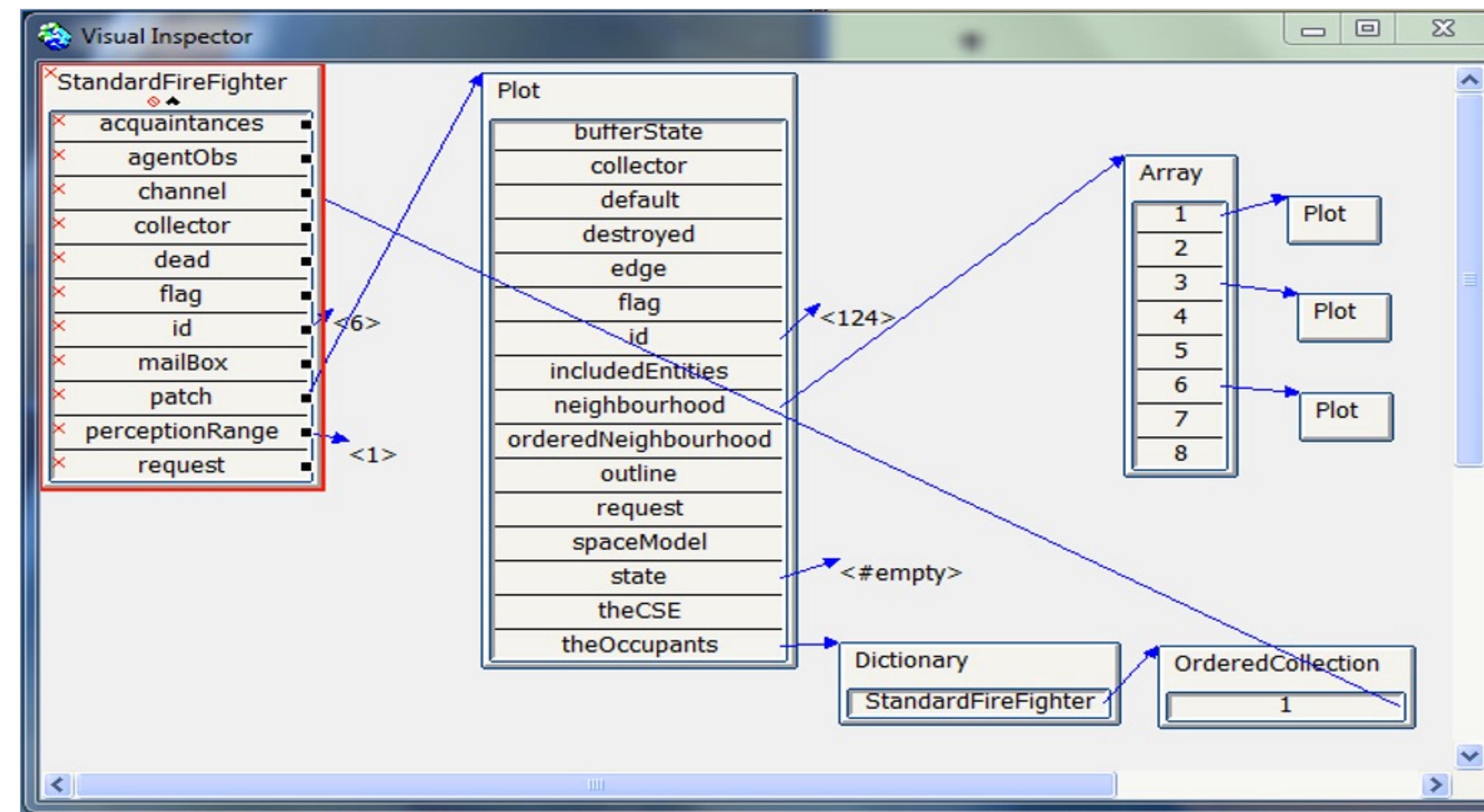
- 3
- Modification of the representations?
 - Considering the constraints of the others?
 - Changes practices?
 - Collective decision?



Designing with UML

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

Visual inspector

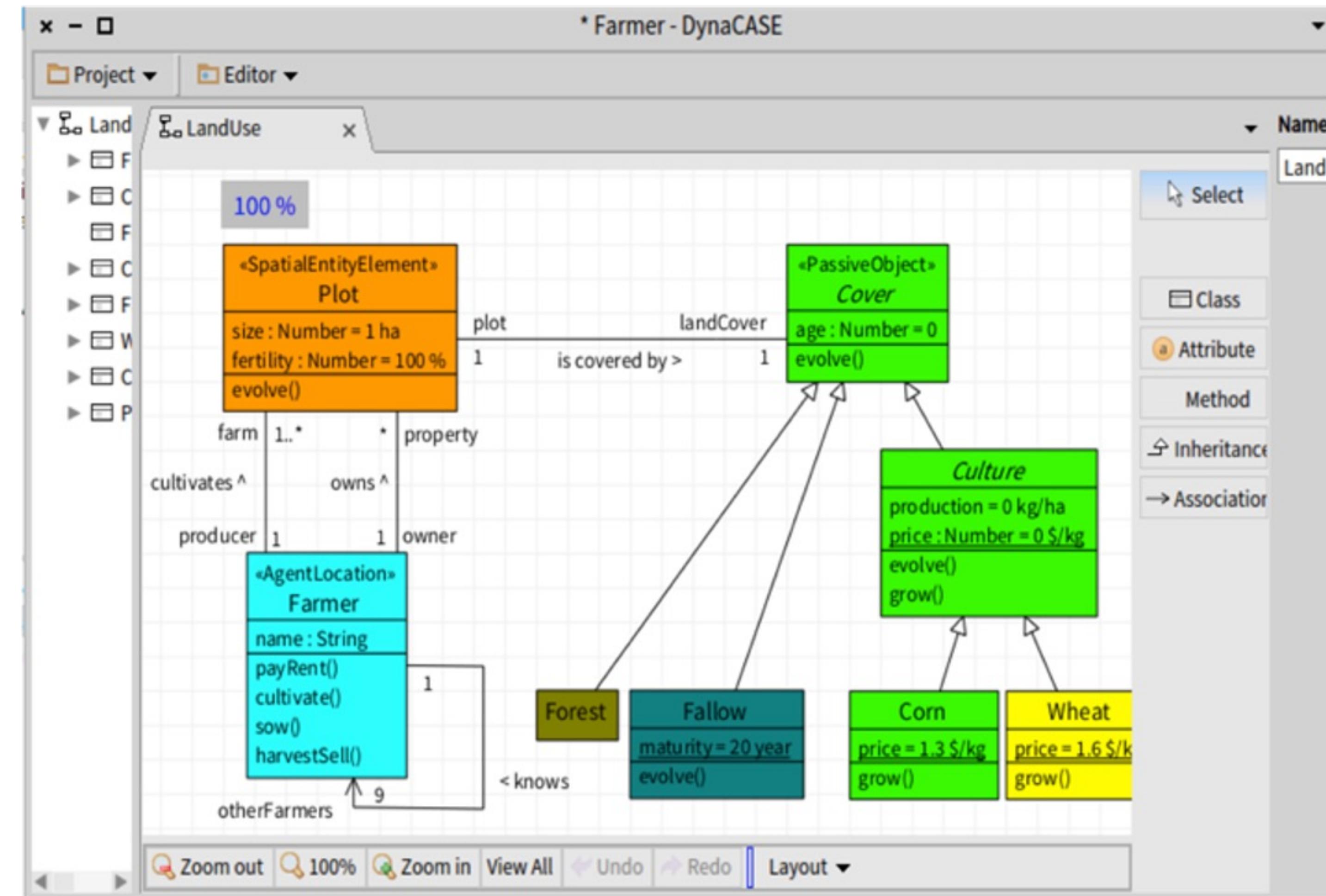


Designing with UML



Common pool Resources
and Multi-Agent Simulations

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



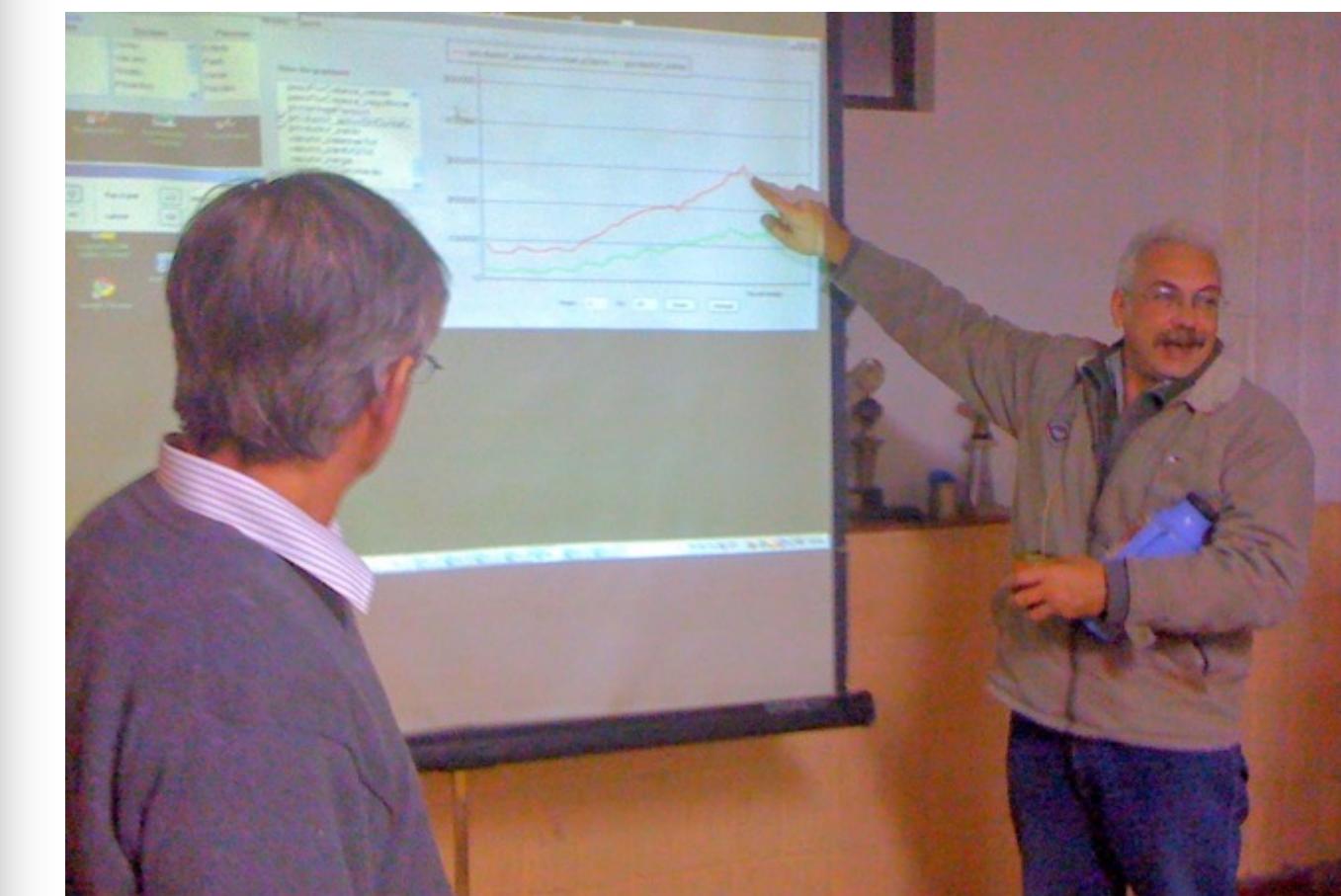
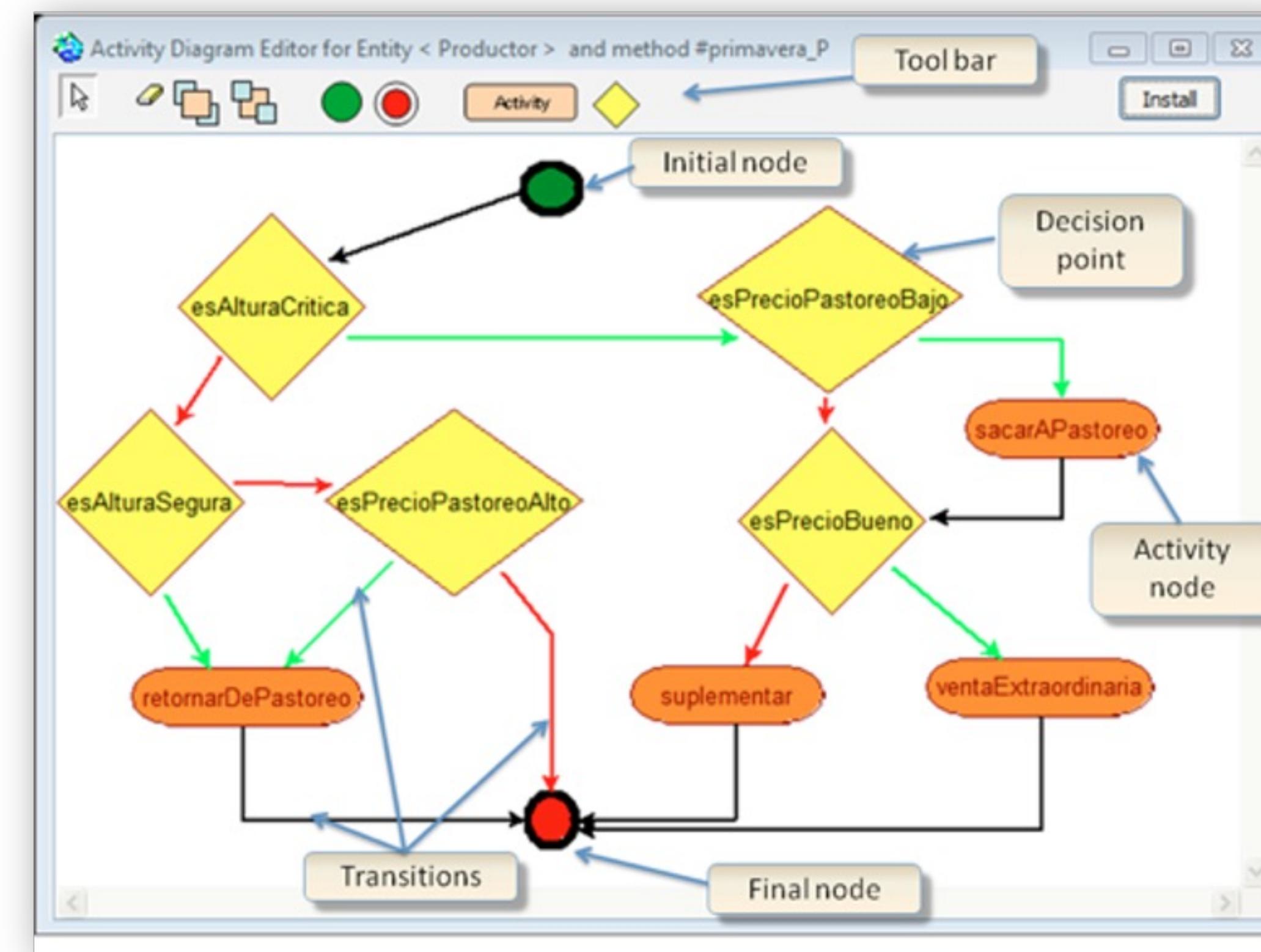
Collective designing with UML



Common pool Resources
and Multi-Agent Simulations



Farmers analysing activity diagrams



Farmer explaining a simulation



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

Entertainment

Used as a hobby for entertainment and challenge

Entertain

Games for research

Integrated into research processes to collect data or validate hypotheses

Provide answers

Educational games

Used as a teaching tool and integrated into learning modules

Acquire new skills and knowledge

Games for intervention

Used to provide opportunities for exchange, information sharing and critical reflection

Open up new perspectives, change

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

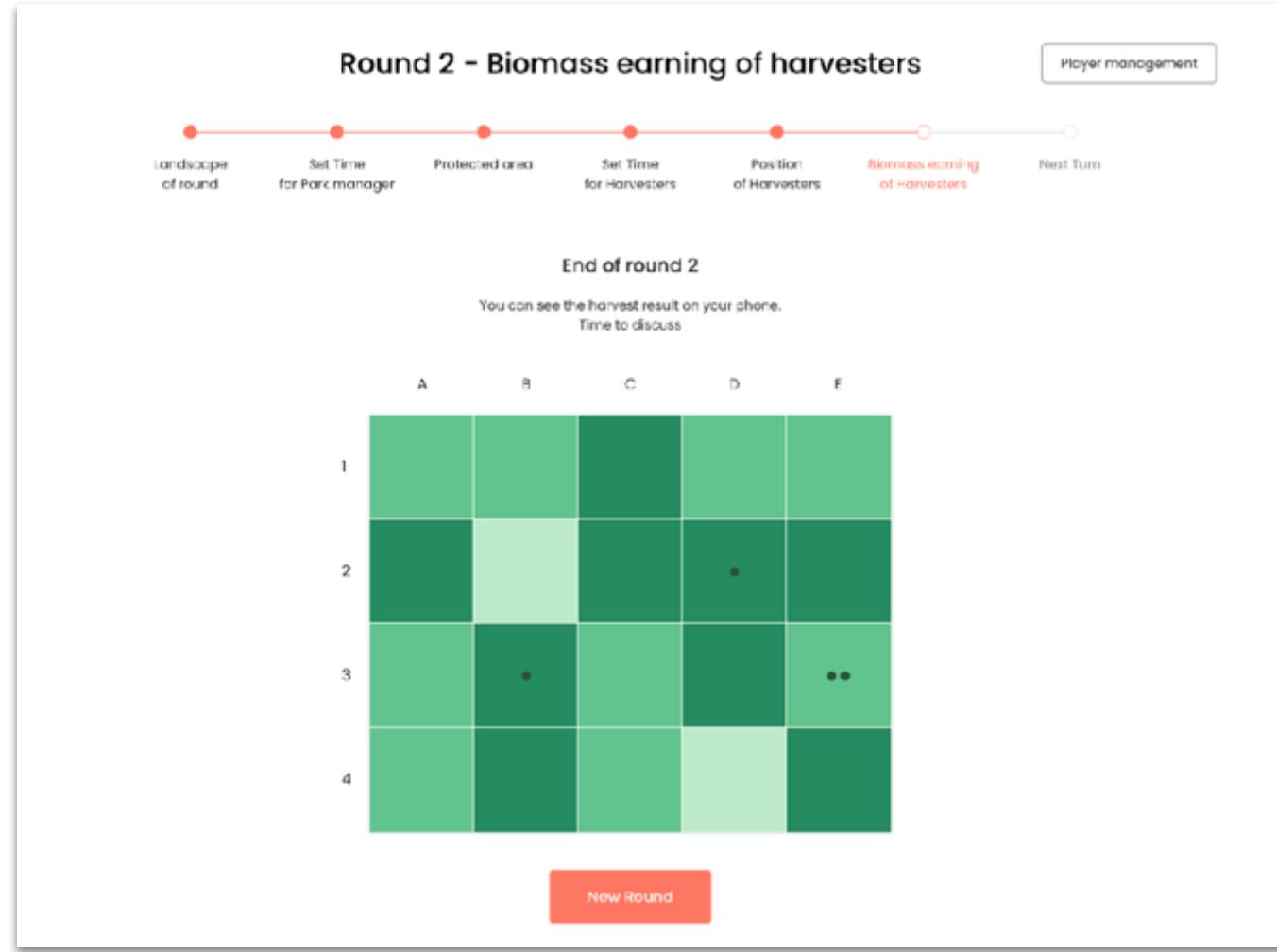
Even people who cannot read or write and have never used a computer can participate in a simulation represented on a game board



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



<https://planetc.org/>

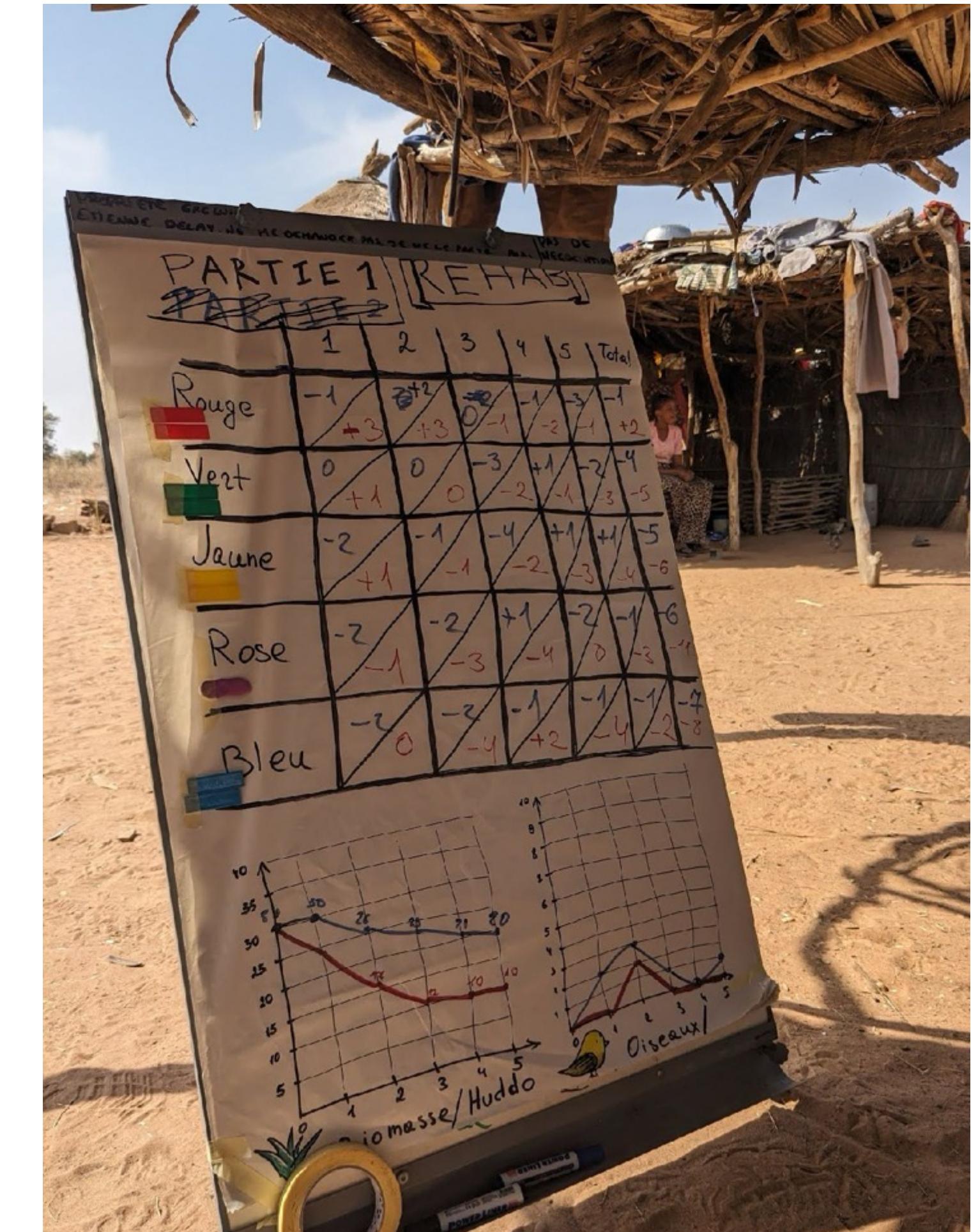
Example of game: Planet C



"Because there is no Planet B"



Oleksandr Zaitsev © Cirad



Oleksandr Zaitsev © Cirad

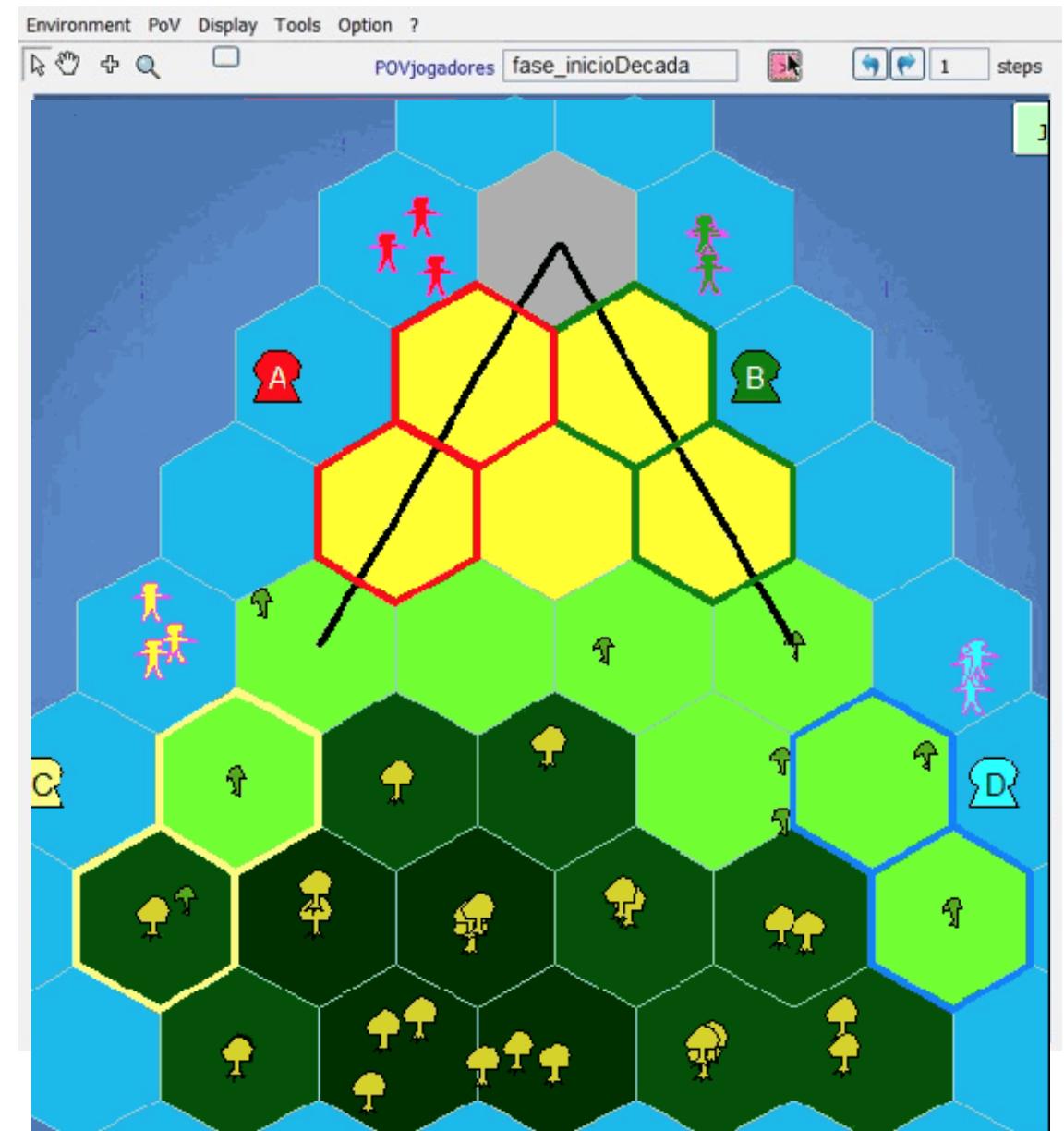
Example of game: Dukunú Molê



Loose translation from Fôrro 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

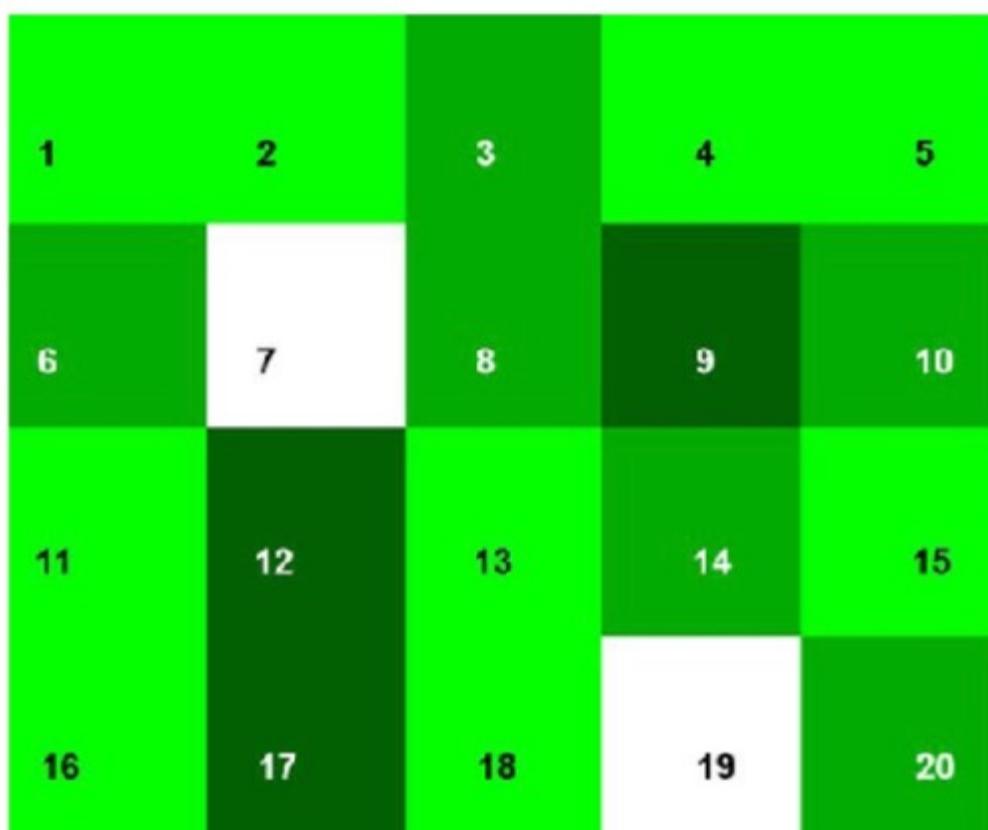


The more complex is the game, the harder it is to manage. Facilitators have to remember all the rules and quickly update the environment in response to players' actions

Help Facilitators

Facilitators use a software tool to perform calculations

Players don't see the tool



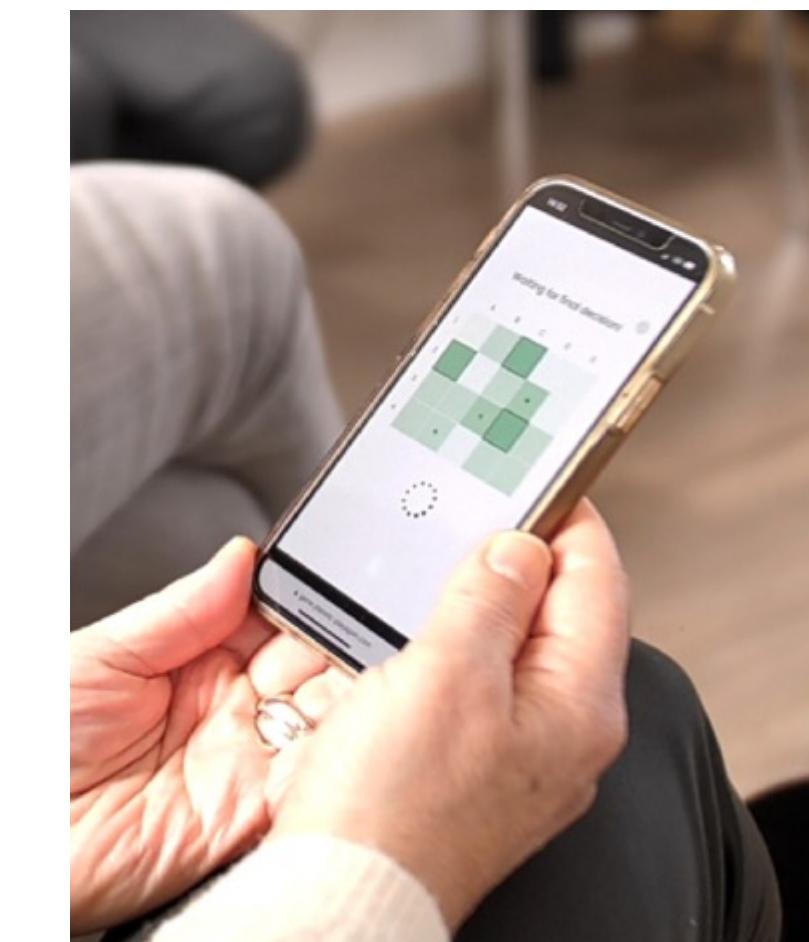
Update the Environment

The tools 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

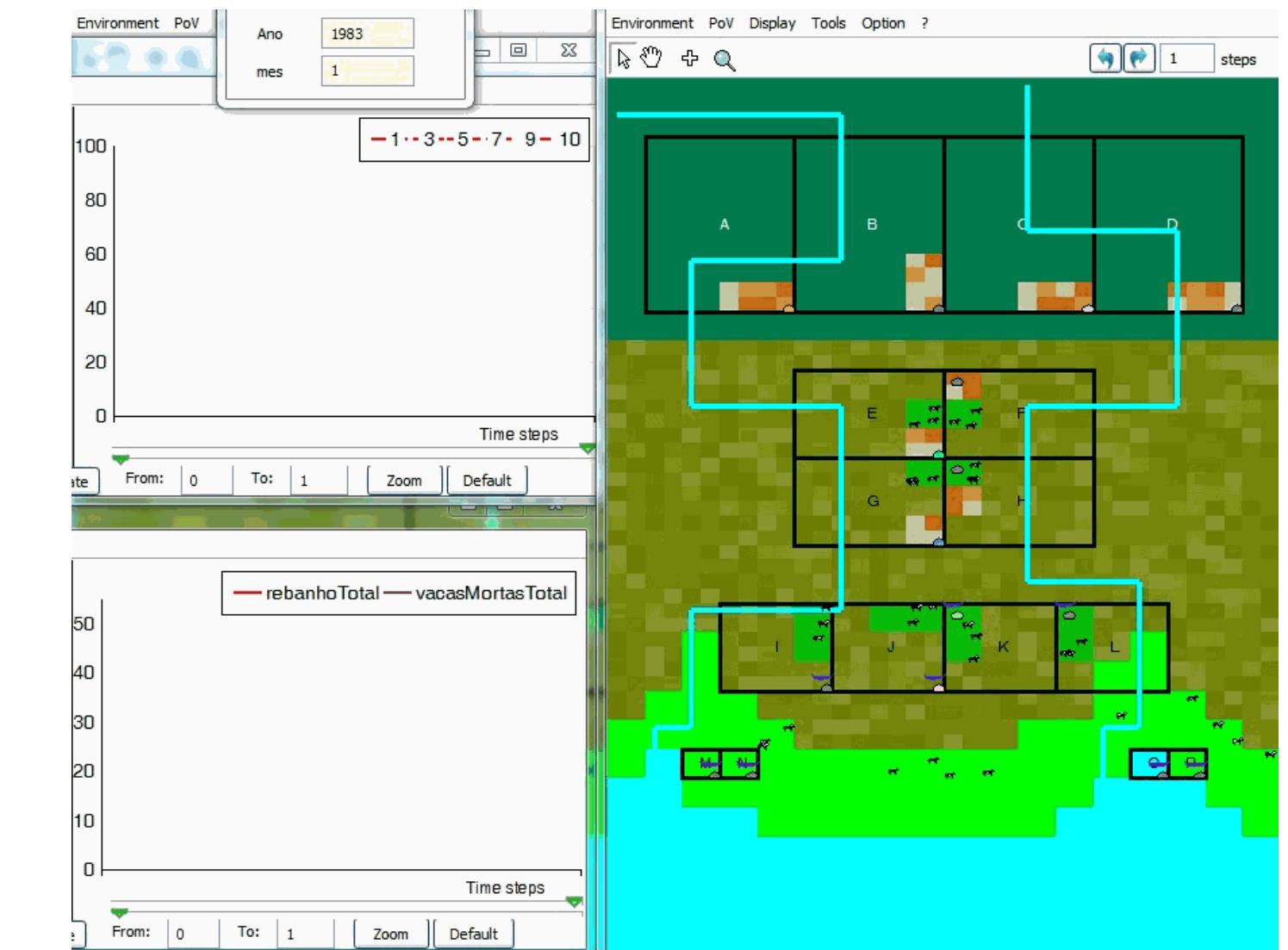
100% human RPG



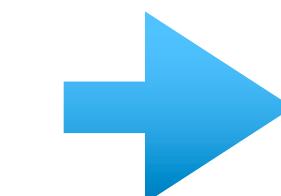
... Intermediate ...



100% computerized ABM



Debriefing: the most important phase



Empower citizens to be the actors of their own social transformation



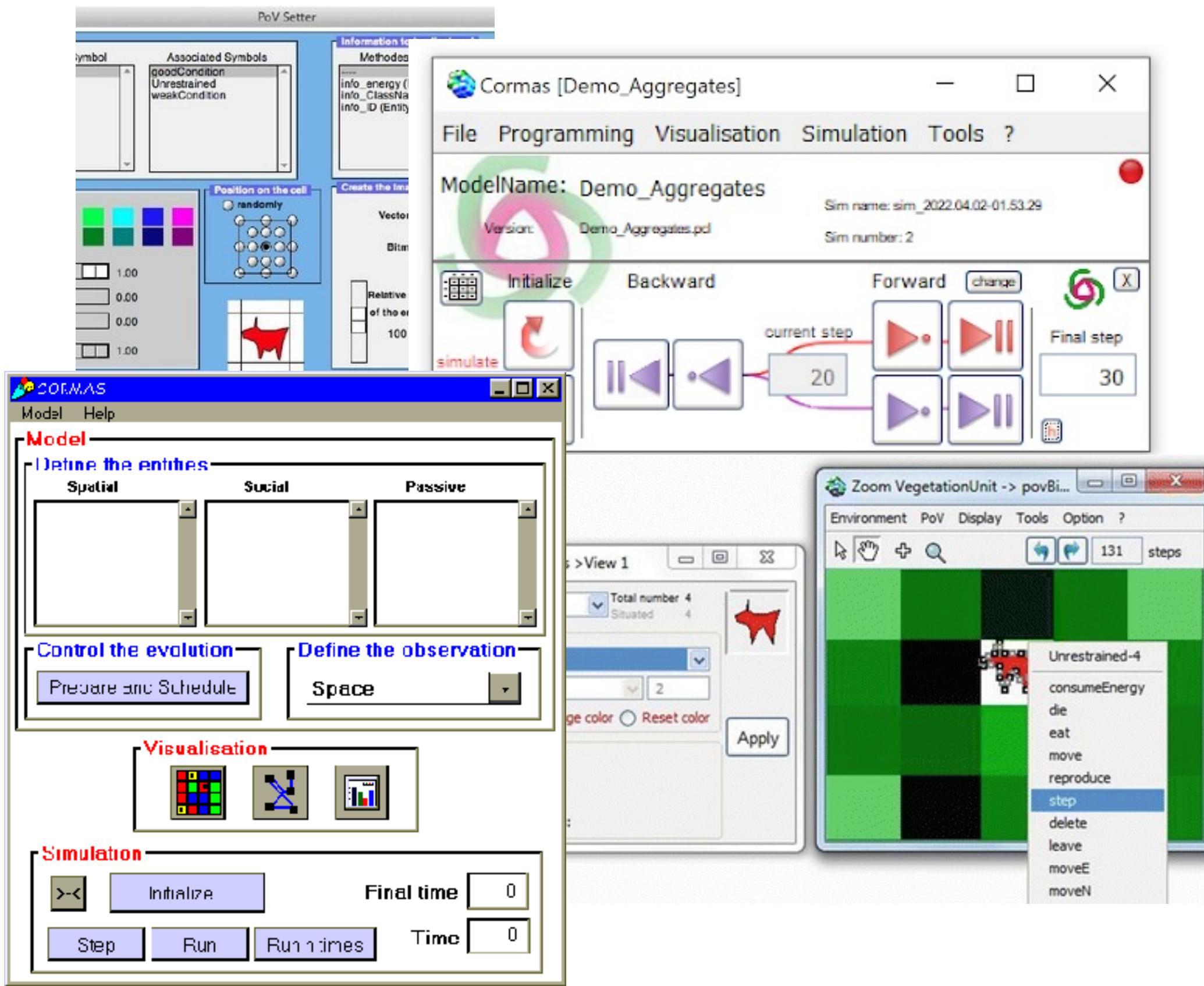
Part 5:

Computer Science Challenges

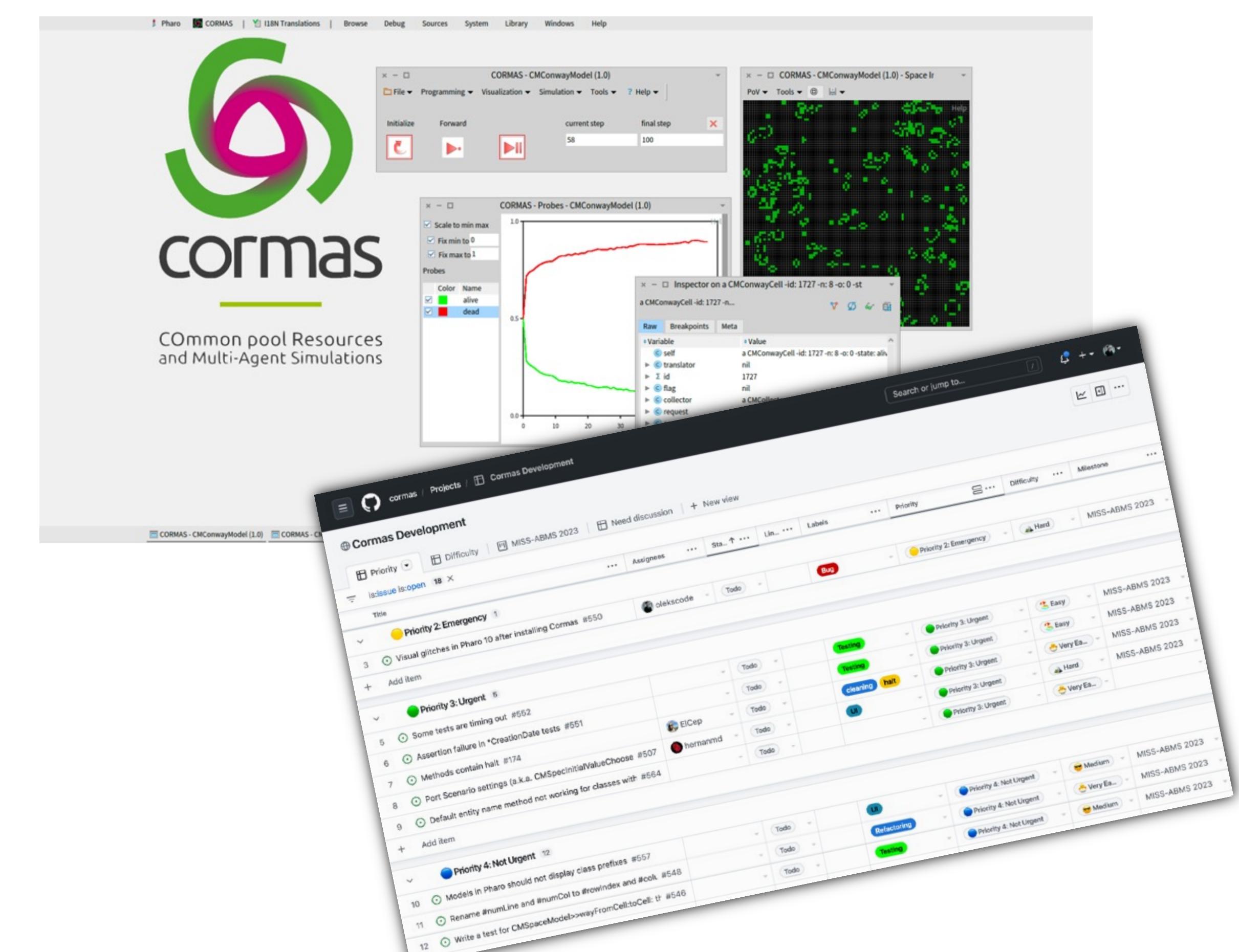
Migrating from VW to Pharo



Visual Works Cormas (discontinued)



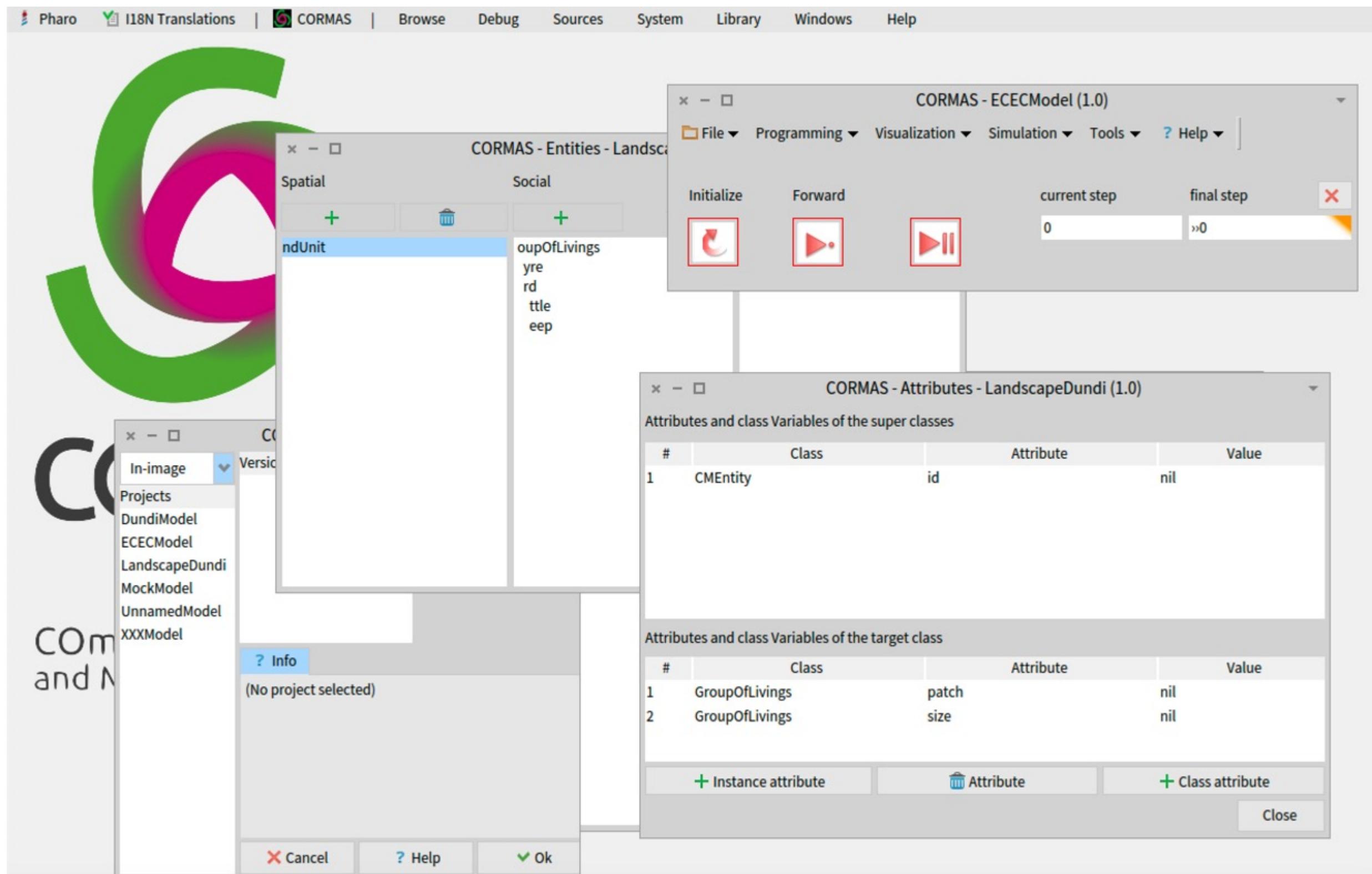
Pharo Cormas



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

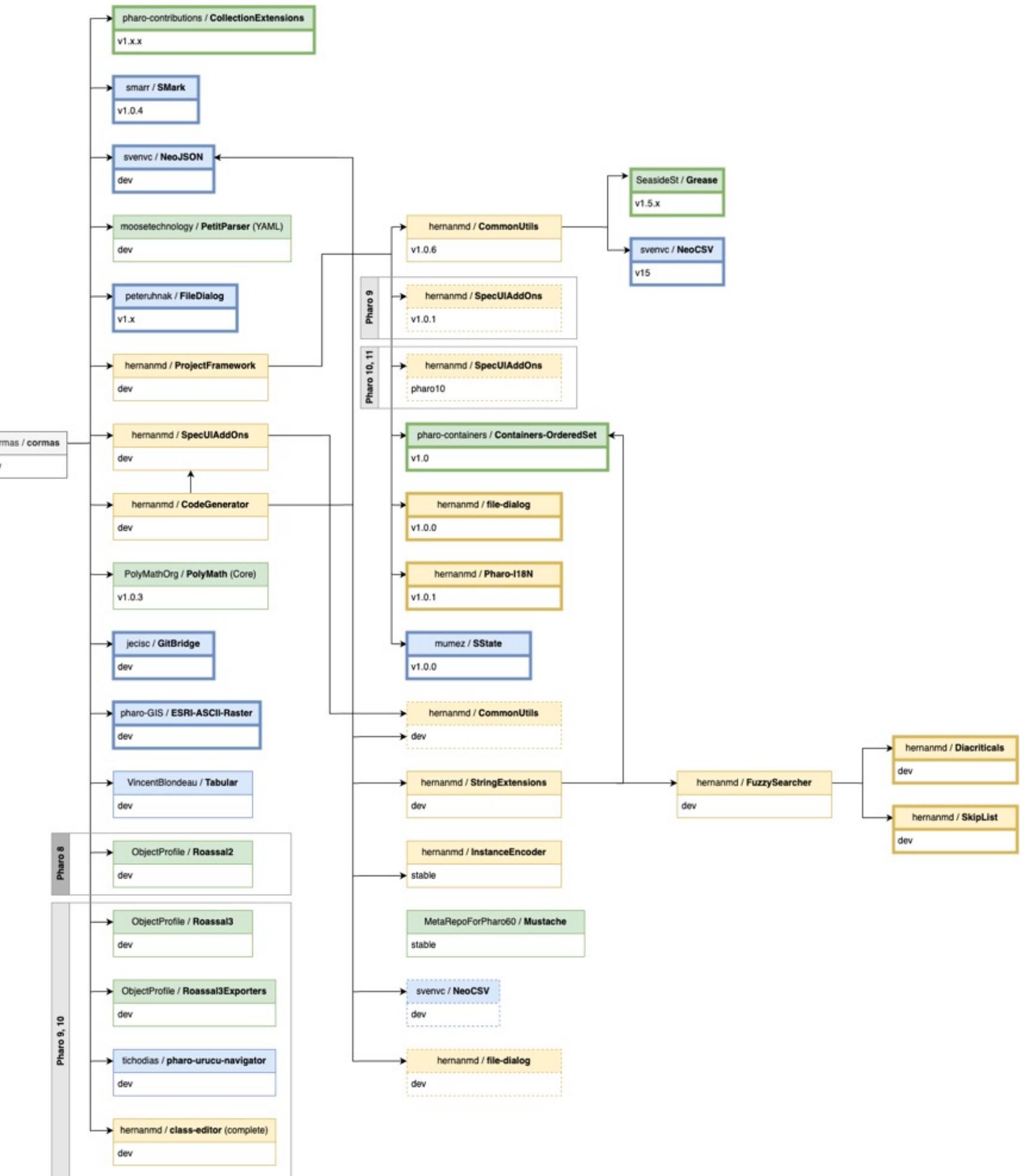
- ▶ Hernan's ideas
- ▶ Re:Mobicity

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



Define a model,
run a simulation,
generate data

Should **be small**,
have minimum
dependencies,
have good tests

Visualise the space,
different POV, square
/ hexagonal cells,
sprites

Depend on Roassal
(or Bloc)

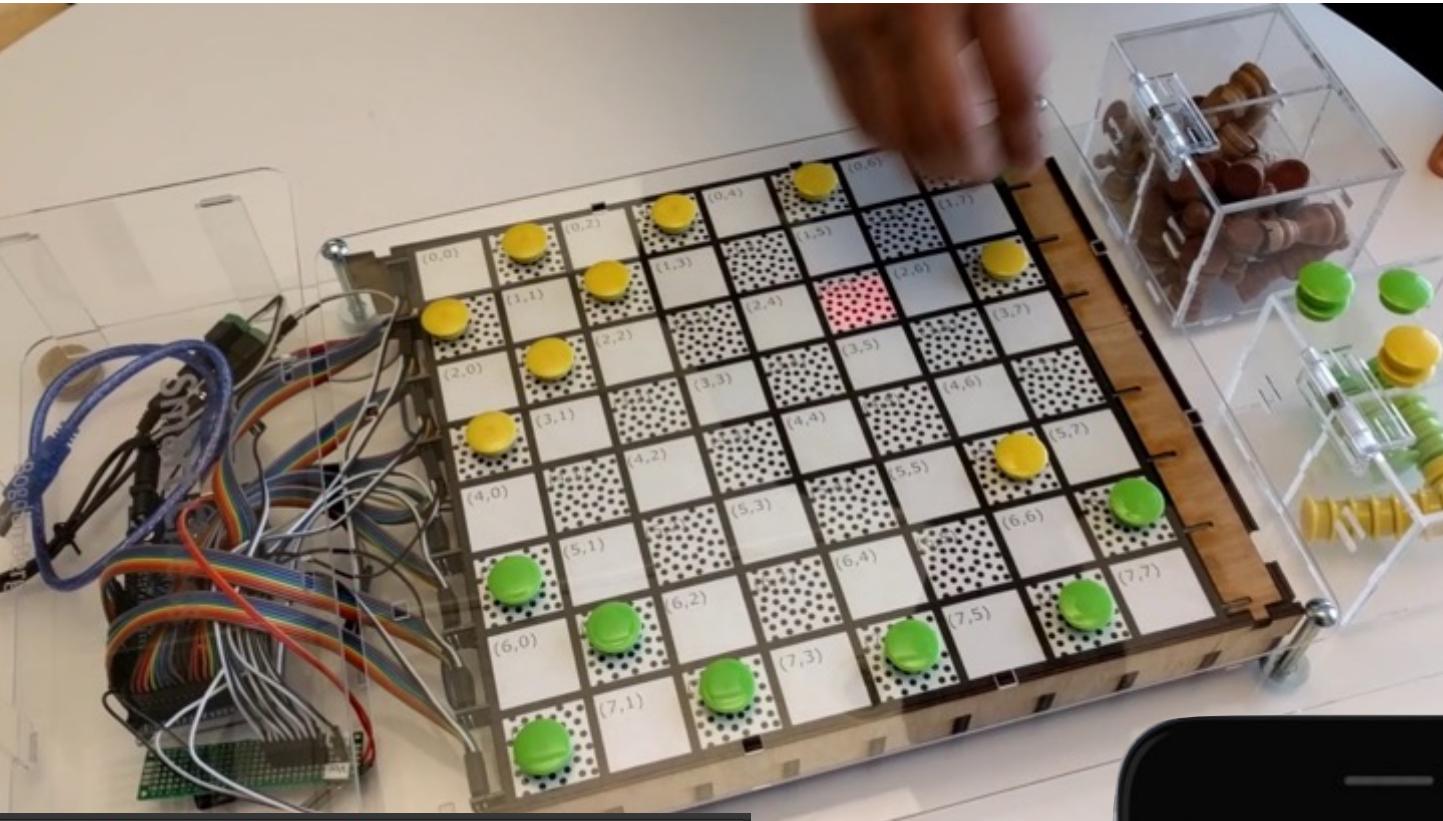
Accessible and
interactive UI to build
models & run
simulations

Depend on Spec
(or Toplo)

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

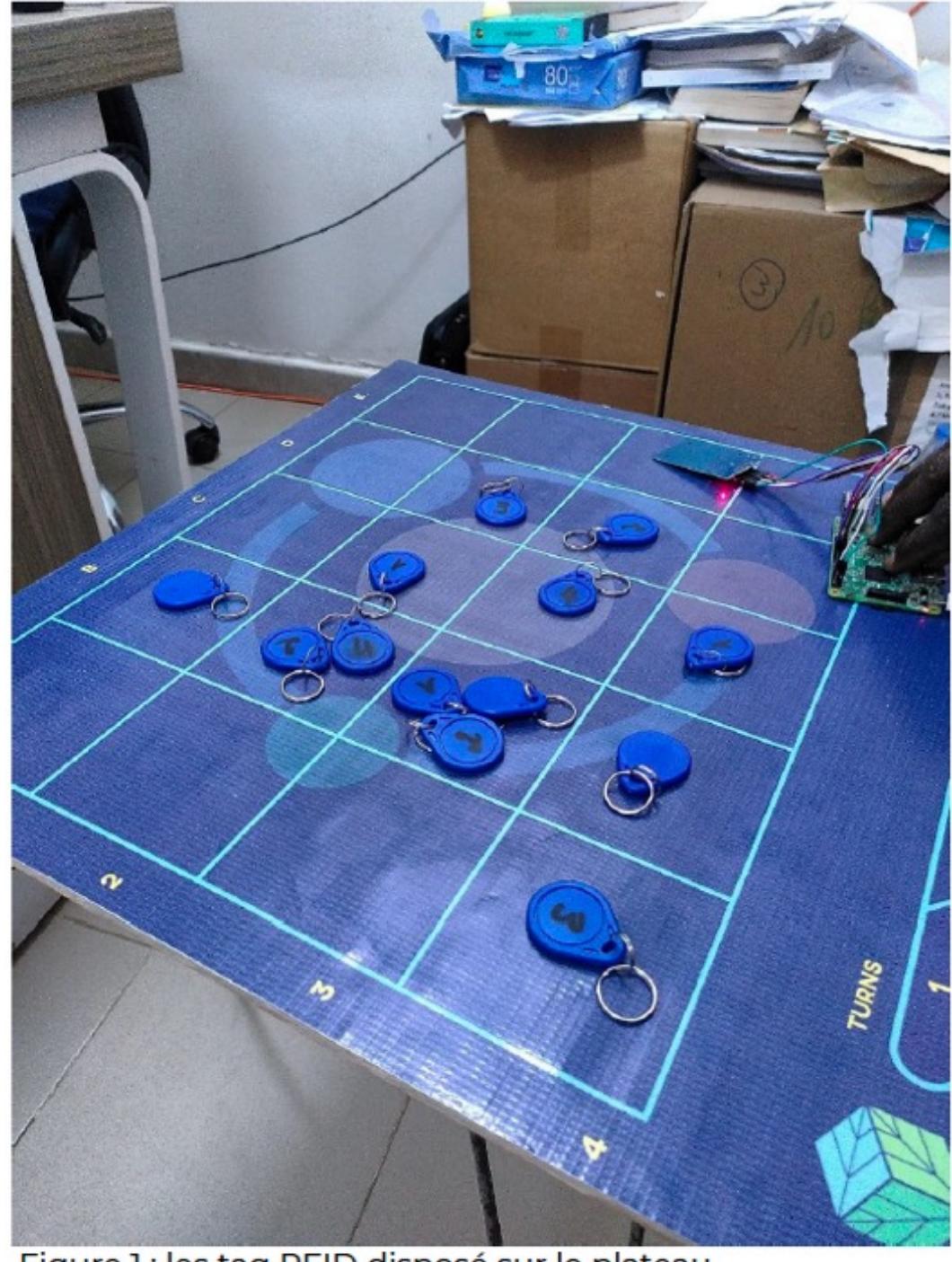


Figure 1 : les tag RFID disposé sur le plateau



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

Developed by our colleagues from
Cheikh Ante Diop University in Senegal
(UCAD, ESP)

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

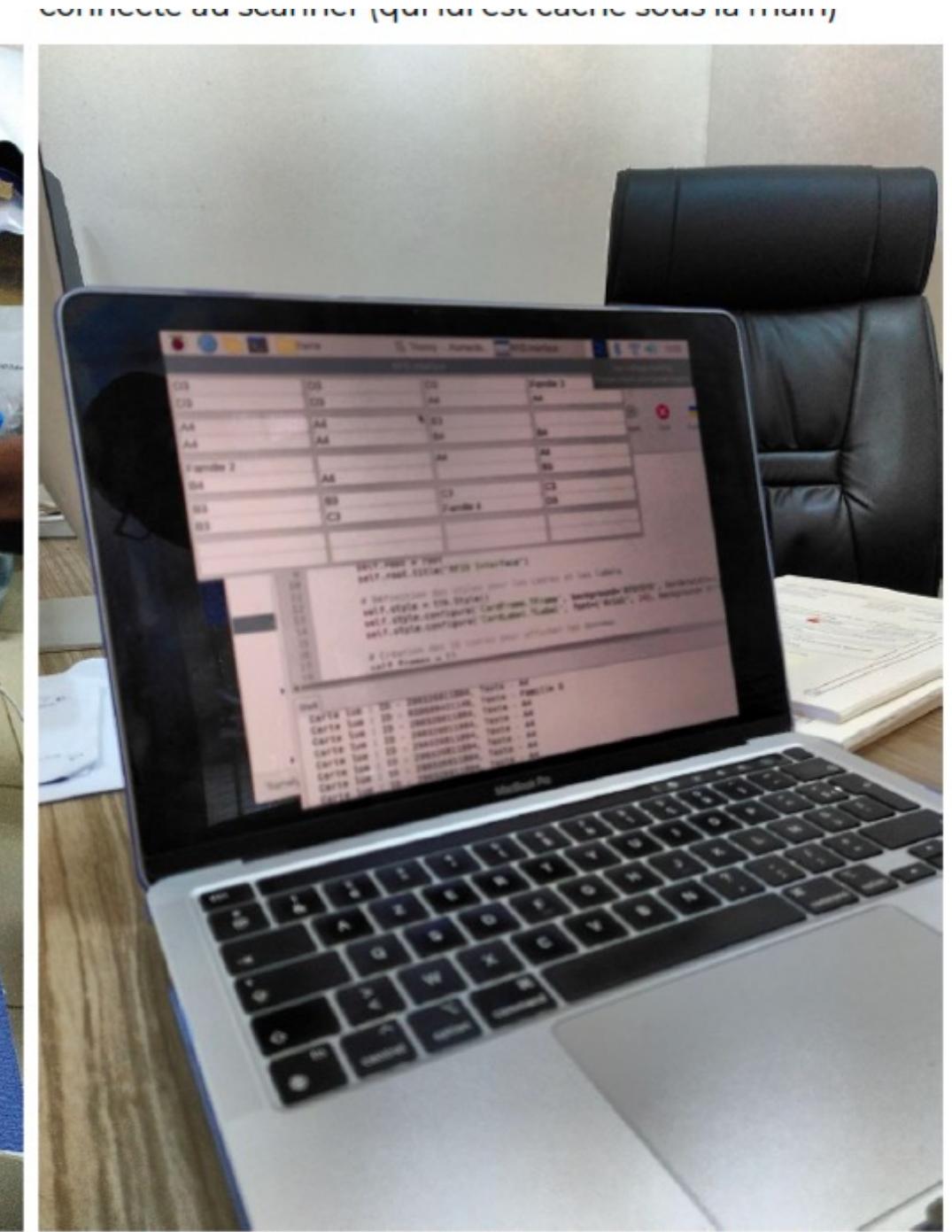


Figure 4 : Les éléments sont affichés sur l'interface en python du raspberry auquel l'ordinateur est connecté via vnc

Challenge: Debugging ABM



Modellers may ask different debugging questions than other developers

Software Development

Developers have to explore large code bases with many dependencies

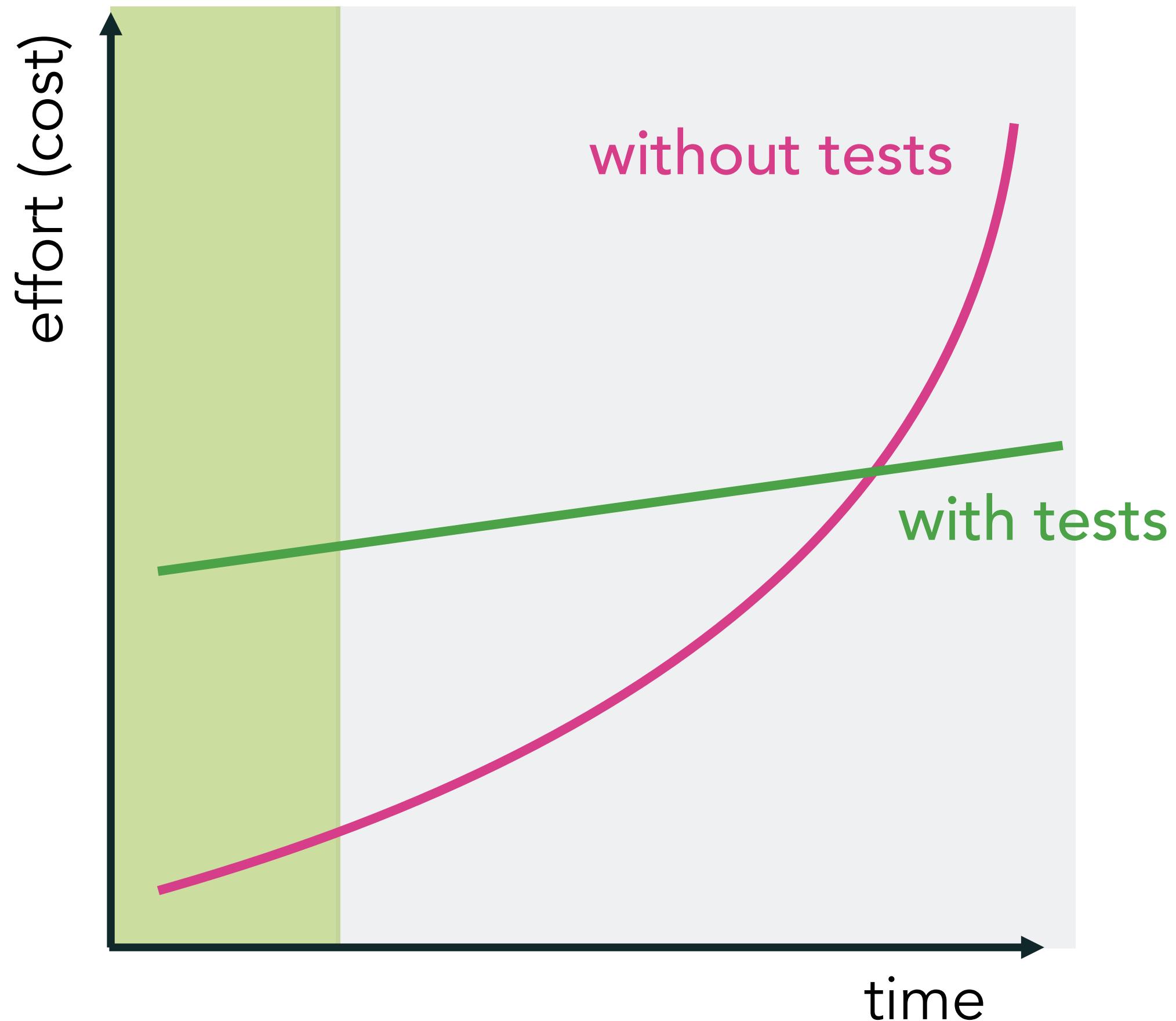
Modelling

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

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

Follow Cormas

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

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

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

Learn Pharo

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

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

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