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

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



COmmon pool Resources and Multi-Agent Simulations https://umr-sens.fr/

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







Reciprocal dependencies Norbert Elias Theory of structuration Anthony Giddens

Emergence,

Methodological holism **Emile Durkheim**

Pierre Bourdieu

ABM examples (Cormas VW) Groundwater pollution in Costa Rica











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Example of ABM (Cormas VW)

Alternative farming practices to deforestation in the Amazon

raditional Annual Cro







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Example of ABM (Cormas VW)

Emergence of resource-sharing conventions

Network evolution





Savannah landscape mosaic under shifting cultivation, North Cameroon



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CBB spread in Central America

Coffee rust spread in Nicaragua



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



Now, implemented in **Pharo** ✓ MIT Licence ✓ Dynamic community

COmmon pool Resources and Multi-Agent Simulations



Based on years of field experience

✓ Well-suited for **companion mode**

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Part 3: The Companion Modelling Approach





Companion Modelling

Environment

(common

resources)

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

Michel Étienne Editor

Companion Modelling

A Participatory Approach to Support Sustainable Development

2 Speinger





Do not provide "ready to use" solutions







Designing with UML

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





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Visual inspector

Designing with UML



the structure of the code

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Class diagram: Editor for collaborative modelling and generating

(Uhnak & Bommel 2016)



Collective designing with UML



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

COmmon pool Resources and Multi-Agent Simulations



Farmers analysing activity diagrams





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.







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

Games for research

Integrated into research processes to collect data or validate hypotheses

Entertain

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

Rodela at al., 2019



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 Compute

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





Computerized board game

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Povjogadores

Tase_inicioDecada

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Povjogadores

The Cormas grid



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





Debriefing: the most important phase



Cirad

... Intermediate ...

100% computerized ABM



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)





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(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





Visualisation

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 Anti Drop University in Senegal (UCAD, ESP)





HELLE AN SCALINE IN AN IN CSL CACHE SOUS IN THAT



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

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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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

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

https://books.pharo.org/

