

# PhD Position F/M Modular architecture for twin games. Connecting physical and digital

**Type of contract:** CDD (Fixed-Term Contract)

**Required degree level:** Bac +5 or equivalent

**Position:** PhD Student

**Dates:** January 2026 - January 2029 (3 years)

**Doctoral school:** [I2S \(Information, Structures and Systems\)](#), University of Montpellier

**Keywords:** twin games, object-oriented design, reflective programming, software modularity, agent-based modeling, live programming, software architecture

## Context

Games are powerful tools for learning, decision-making, and collaboration—and this PhD project is about pushing their boundaries. It explores the next generation of serious games: "twin games" that connect physical gameplay with real-time digital simulations.

Within the Companion Modelling (ComMod) approach, board and role-playing games (RPGs) are widely used to involve stakeholders in modeling complex socio-ecological systems. These games are applied in diverse regions in order to support collective learning and negotiation in real-world development contexts. However, the physical nature of these games often limits their speed, reproducibility, traceability, and integration with computational models.

Recent advances in live programming environments, reflective software architectures, and tangible interfaces now make it possible to build hybrid serious games that tightly couple physical components with digital simulations. By eliminating the need for the facilitator to enter participants' decisions, these "twin games" enable new forms of interaction, transparency, and adaptability in participatory modeling.

This PhD is situated at the intersection of game design, software architecture, and participatory modeling. It aims to design a modular and reusable architecture for the rapid prototyping of twin games using the Cormas agent-based modeling platform. The project will rely on Cormas, implemented in Pharo—a live, object-oriented programming environment well-suited for building reflective and modular systems. The research will be conducted in close collaboration with ComMod and CIRAD researchers who will apply and test the resulting tools and prototypes in field-based participatory modeling initiatives across Africa and South America. It also contributes to broader initiatives of the ComMod community, including the TOrHs project (Tangible object recognition for hybrid simulations) on smart boards for participatory games.

## Objectives

The main objective of this PhD is to investigate the theoretical and technical foundations of "twin games" - hybrid serious games that connect physical interactions with real-time digital agent-based simulations. These systems offer new opportunities for supporting

participatory modeling, collaborative learning, and co-design in complex socio-ecological contexts.

More specifically, the PhD aims to:

1. **Theorize and formalize the architectural and interaction principles underlying twin games**, including how physical and digital elements can be jointly represented, synchronized, and made interoperable in participatory settings.
2. **Develop and analyze a modular, reflective software framework** within the Pharo-based Cormas platform, enabling experimentation with architectural variants, live reconfiguration, and reusable components for hybrid simulations.
3. **Investigate participatory model design environments** that empower non-programmers to contribute to the structure and dynamics of models through intuitive interfaces, bridging the gap between domain knowledge and model implementation.
4. **Examine challenges in distributed and multi-user settings**, including mechanisms for concurrent interaction handling, consistency management, and resilience to communication failures and network disruptions.
5. **Conduct empirical studies through co-developed case studies with CIRAD and ComMod partners**, critically assessing how twin games influence user engagement, model comprehension, and the quality of participatory processes.

The project will contribute original insights to the fields of software architecture, human-computer interaction, and participatory modeling, while producing theoretical frameworks and software tools with practical applications in sustainability science.

## Research unit

The PhD will take place at [UMR SENS \(Savoirs, Environnements, Sociétés\)](#), a joint research unit between CIRAD, IRD, and the Paul Valéry University of Montpellier. UMR SENS focuses on the co-production of knowledge and models to support sustainability transitions in socio-ecological systems. This interdisciplinary unit combines social sciences, ecology, modeling, and participatory methods.

The hosting institution, [CIRAD](#) (French Agricultural Research Centre for International Development), is a public research institution working for the sustainable development of tropical and Mediterranean regions. CIRAD is internationally recognized for its collaborative work with researchers and stakeholders from the Global South, especially through long-term partnerships and field-based research.

This PhD is co-supervised by the [SMILE team at LIRMM](#), Montpellier, a team specialized in modeling and simulation of Multi-Agent Systems and by the [Evref team \(RMod\)](#) at [Inria Lille](#), a research team specialized in software architecture, reflective systems, and live programming environments. Evref develops tools and methodologies to build flexible, modular, and introspective software systems. Their expertise in live

environments and modular programming will support the software architecture dimension of the project.

The selected candidate will be enrolled in the [I2S Doctoral School](#) (Information, Structures and Systems) at the University of Montpellier, which offers scientific training, research seminars, and interdisciplinary collaboration opportunities in computer science, systems modeling, and data analysis.

## Supervisors

- Dr. HDR Fabien MICHEL, LIRMM - University of Montpellier (directeur)
- Dr. HDR Pierre BOMMEL, CIRAD UMR SENS (co-directeur)
- Dr. Oleksandr ZAITSEV, CIRAD UMR SENS (encadrant)
- Dr. Pablo TESONE, Inria Evref team (encadrant)

## Expected profile and skills

- Applicants must hold a Master's degree or equivalent in computer science or a closely related field.
- A strong level of English is essential (minimum B2 level); proficiency in French is an advantage.
- Solid understanding of object-oriented programming. Prior experience with the Pharo programming language is a significant plus.
- Experience with academic writing or scientific communication.
- Familiarity with agent-based modeling platforms or simulation environments.
- Interest in serious games, participatory modeling, or sustainability issues.
- Capacity to work both independently and collaboratively within interdisciplinary and international research settings.

## Contacts

Motivated candidates must submit a detailed curriculum vitae and a cover letter to Fabien MICHEL, Oleksandr ZAITSEV and Pierre BOMMEL before **October 9, 2025**. The selected candidate will then be interviewed during the last week of October by the thesis supervisors.

For more information, please contact:

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