



Post-doc: Sensitivity and Uncertainty Analysis of the MAELIA model

Position category A

Role: Post-doctoral researcher

The contract is a fixed-term, full-time public contract for **24 months** (subject to experience).

Salary: between 2289 and 3100 euros **gross per month, depending on experience.**

Start date : beginning 2025

Supervisor: Benoit Gaudou (Professor, IT Faculty, University Toulouse Capitole, IRIT)

Required Degree / Desired Experience: **Minimum PhD** (with a modeling and simulation profile).

The University of Toulouse Capitole is hiring a Postdoctoral Researcher to strengthen the research activities of the IRIT laboratory hosted by the Faculty of Computer Science.

ABOUT THE UNIVERSITY

The University of Toulouse Capitole became an Experimental Public Institution on January 1, 2023, building on a long academic tradition. The institution currently includes the following components: Faculty of Law and Political Science, Toulouse School of Management, Faculty of Administration and Communication, Faculty of Information Technology, Rodez University Institute of Technology (IUT), and two specialized establishments: Toulouse School of Economics and Sciences Po Toulouse.

With nearly 20,000 students, 700 faculty researchers, and 600 administrative staff, the university aims to: establish a multidisciplinary and international research hub, foster local and international partnerships, promote educational innovation, and enhance the attractiveness of Toulouse as an academic destination.

ABOUT THE IRIT LAB

The Toulouse Institute of Computer Science Research (IRIT, <https://www.irit.fr>) is one of France's largest joint research units (UMR 5505). With 600 members and about 100 external collaborators, IRIT is a cornerstone of research in the Occitanie region. Its multi-institutional structure (CNRS and Toulouse universities), scientific impact, and interdisciplinary collaborations make it a driving force in computer science and digital applications at regional and national levels.

This position is funded by the SLAM-B project (<https://www.slamb.fr>) under the PEPR FairCarbon frame (<https://www.pepr-faircarbon.fr>).

CONTEXT: SLAM-B PROJECT

Achieving carbon neutrality by 2050 and promoting sustainability require the development of a bioeconomy that addresses production and transformation challenges while preserving natural resources. Territorial approaches integrating agroecology, resource optimization, collective action, and virtuous interdependencies (e.g., circular economy, urban-rural synergies) are essential.

Integrated Assessment and Modelling (IAM) approaches are recognized for supporting stakeholders in designing human activity systems for a sustainable bioeconomy. These methods combine multidisciplinary knowledge and empirical insights to simulate and evaluate scenarios under various conditions. The SLAM-B project aims to build a French research community to advance IAM approaches for sustainable bioeconomy development rooted in agroecology. It addresses three major scientific challenges: (i) Developing generic IAM methods to simulate bioeconomic transitions and anticipate their consequences, (ii) Demonstrating IAM's relevance through Living Labs with a prospective focus, called Scenario Labs, and (iii) Generating tailored insights for national and European policymakers.

To achieve these goals, SLAM-B will significantly enhance the functionality of the MAELIA platform, a multi-agent integrated modeling tool for agricultural and bioeconomic systems (<http://maelia-platform.inra.fr>). MAELIA uses the GAMA agent-based modeling platform (<https://gama-platform.org>).

ROLE AND OBJECTIVES

The postdoctoral researcher will develop automated sensitivity analysis and uncertainty evaluation procedures for MAELIA simulations.

This work will be done in a specific context:

- Agent-based models (including MAELIA) are computationally intensive.
- MAELIA is an integrated model coupling multiple submodels.
- A wide variety of sensitivity and uncertainty analysis methods exist, each with specific goals. The tools must integrate seamlessly into the GAMA platform.

Key Objectives:

i. Develop a library of sensitivity and uncertainty analysis methods:

- i. Review and compare existing methods based on objectives and inputs (data, decision rules, etc.).
- ii. Implement a library of methods in the GAMA platform.
- iii. Future goal: Incorporate expert knowledge to guide exploration and adjust trajectories.

ii. Combine Agent-Based Modeling (ABM) with Machine Learning (ML): to identify the key parameters explaining the model behavior.

- i. Create a pipeline combining ML algorithms, feature selection, and explainability tools (e.g., SHAP, LIME) to develop a new sensitivity analysis framework.
- ii. Assess the robustness of explanations.
- iii. Use ML models for model calibration, parameter clustering, etc.
- iv. Future goals: Substitute ML models into the coupled MAELIA model. Evaluate their utility in uncertainty quantification.

iii. The library of sensitivity analysis methods must be **operational, tested on MAELIA** (in one or two SLAM-B Scenario Labs), and **documented** for broader use within MAELIA.

I REQUIRED SKILLS

Knowledge:

- Expertise in simulation and numerical computing: sensitivity analysis, uncertainty evaluation, and propagation.
- Proficiency in Java development.
- Familiarity with agent-based modeling and the GAMA platform is a plus.
- Knowledge of Machine Learning is advantageous.

Skills:

- Ability to write technical and scientific documents in French and English:
 - Reports.
 - Scientific articles.

Soft skills:

- Ability to work collaboratively in interdisciplinary teams and adapt to diverse stakeholders.
- Independence and initiative.
- A proactive, solution-driven mindset.

I APPLICATION

Applications (**cover letter and curriculum vitae**) should be sent by email to Benoit Gaudou at: benoit.gaudou@ut-capitole.fr, indicating **the job title in the subject line**. Interviews and selection will be conducted on a rolling basis.