



HAL
open science

Coupling GAMA, R software and the OpenMOLE platform to explore an agent-based model simulating interactions between farms

Aurélien Peter, Romain Reuillon, Myriam Grillot

► **To cite this version:**

Aurélien Peter, Romain Reuillon, Myriam Grillot. Coupling GAMA, R software and the OpenMOLE platform to explore an agent-based model simulating interactions between farms. GAMA Days 2024, Nov 2024, Online, France. hal-04887937

HAL Id: hal-04887937

<https://hal.science/hal-04887937v1>

Submitted on 15 Jan 2025

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Coupling GAMA, R software and the OpenMOLE platform to explore an agent-based model simulating interactions between farms

Aurélien Peter¹, Romain Reuillon², Myriam Grillot¹

¹ UMR AGIR - INRAE

² ISC-PIF - CNRS

myriam.grillot@inrae.fr

Keywords

agent-based model; crop-livestock interaction; farm network; model exploration

Abstract

Crop-livestock systems at landscape level encompasses interactions between specialized agricultural systems. Materialized by biomass flow between farms, these interactions can increase farm self-sufficiency (SS) and local resource circularity (manure, forage, grain, straw) [2]. However, it remains unclear how these interactions occurs and to which extent the resulting farm network enhances performance and resilience towards external hazards at both farm and landscape levels.

To better understand these processes, we built an agent-based model that simulates individual farms able to take independent decisions on interactions through biomass flows while considering social behaviors [1]. We implemented it in the GAMA modeling platform. To efficiently perform model explorations for its parametrization, verification and validation, we coupled GAMA simulations to the R software using the workflow facilities of OpenMOLE (<https://openmole.org/>).

In the ABM, agents are farms (either cereal, livestock or crop-livestock) and the cooperative localized in the Ariège region (France). At each time step (year), farms produce biomass that can be exchanged with other farms, the cooperative or the global market. Exchange decisions are based on a score that considers i) exchange distance, ii) exchangeable biomass quantity iii) trust between farms, which reflects farm exchanging habits and evolves based on past exchange experiences. Farm individual preferences give more or less weight to one or other of these variables.

At initialization, we use random farm locations (according to regional farm type distribution) and compute farm distance in order to quicken the scoring process for exchanges at each cycle. Farm distance computation is time-consuming when farm number is high (10 minutes for 300 agents) in GAMA. Thus, we produce the farm localization dataset with GIS and network packages (igraph, sf, sfnetworks) from the R software. GAMA simulation outputs are also analyzed with the R software to compute performance, network and resilience indicators. Using OpenMOLE, we upscaled the experiments on the large powerful computing environment of the European Grid Infrastructure (EGI) (<https://www.egi.eu/>).

We explored our model with the Sobol sampling technique to define the number of cycles (8) and the number of farm agents (300) to simulate. We also proved that multiple farm location datasets are not necessary to get a diversity of simulation outputs. Pattern Space Explorations (PSE) helped us to choose the indicators that would show a wide diversity in the model output space ; it also indicated us which model mechanisms was worth to keep and which was not. Profile explorations revealed clear relations (sigmoidal curve) between the livestock SS and the farm preference for farm exchanges.

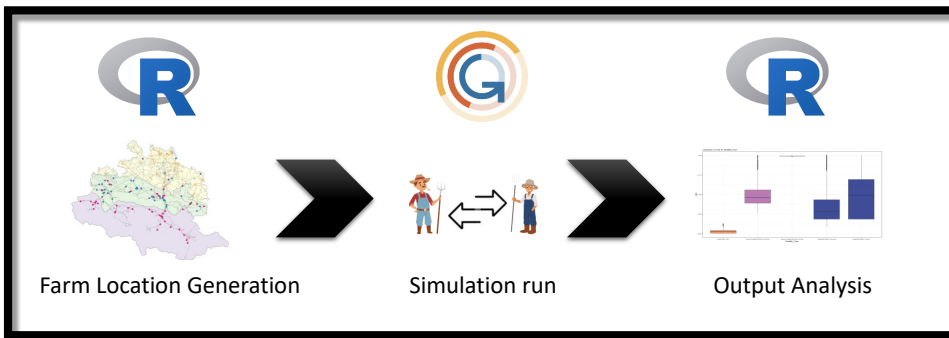
The coupling of the GAMA model with R software using the OpenMOLE (with three different methods) guided and supported the model parametrization to establish a reference in the Ariège region. The pipeline (structure, scripts and coupling) will be presented at the conference. Next steps are i) to decompose the reference into multiple baselines with different farm network 'strength', ii) apply scenarios to show if the network 'strength' can influence its performance and resilience.

References

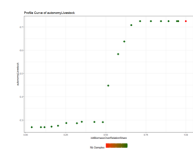
- [1] Robert Huber et al. "Representation of decision-making in European agricultural agent-based models". In: *Agricultural systems* 167 (2018), pp. 143–160.
- [2] Guillaume Martin et al. "Crop–livestock integration beyond the farm level: a review". In: *Agronomy for Sustainable Development* 36.3 (2016), p. 53.



Pipeline embedded on the OpenMole platform



Exploration launched on the EGI infrastructure



Exploration Analysis

Figure 1: Coupling GAMA simulations and R software in OpenMOLE