

The need for optimization tools in agent-based models: a GAMA model for flood crisis management

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Abstract

The integration of agent-based modeling and simulation into decision-making tools requires enhancing their realism by supporting intelligent optimized decisions [1]. However, optimization is not a native feature of agent-based models (ABMs), and it is necessary to combine them with existing optimization tools [4]. This complementary approach, combining geospatial simulation with optimization, allows simulators to support realistic decisions that might be necessary to address real-world problems. Such simulators can help test what-if scenarios and assess alternative strategies in different domains where decision-makers need optimized solutions.

In this work, we present a simulator that couples an ABM with a Vehicle Routing Problem (VRP) optimizer [3]. This optimizer uses optimization heuristics that compute the best routes for a fleet of vehicles to minimize their total traveled distance [2]. We use this tool to optimize the evacuation of vulnerable people from risk areas during flood events. The ABM, implemented under the GAMA platform, simulates all the spatial and temporal dynamics (the environment, interactions between actors, and the evacuation process) and communicates with the VRP optimizer to obtain evacuation plans.

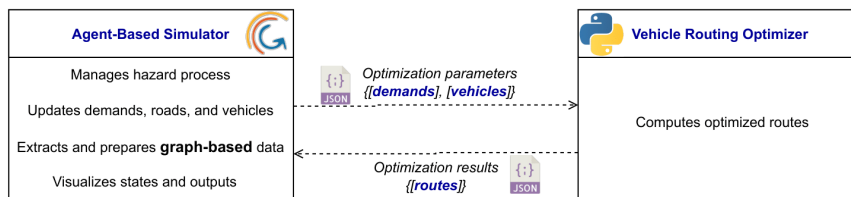


Figure 1: Coupling of the ABM simulator (GAMA) with the VRP optimizer (Python)

We apply this model to the October 2018 flood scenario in the city of Trèbes (South of France). We use the GAMA platform in graphical mode to visualize and calibrate scenarios, then in headless mode to run multiple parallel simulations with different input parameters. The aggregation of these simulation outputs helps crisis managers decide on the best evacuation strategies according to several parameters: the number of available emergency vehicles, the location of evacuation centers, and the evolution of the flood hazard. This application shows that coupling ABMs with optimization tools is relevant in addressing real-world situations. We believe that integrating optimization tools into GAMA could ease the development of such applications.

Additional material

Demonstration video: <https://youtu.be/sL5GHBmCvko>

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