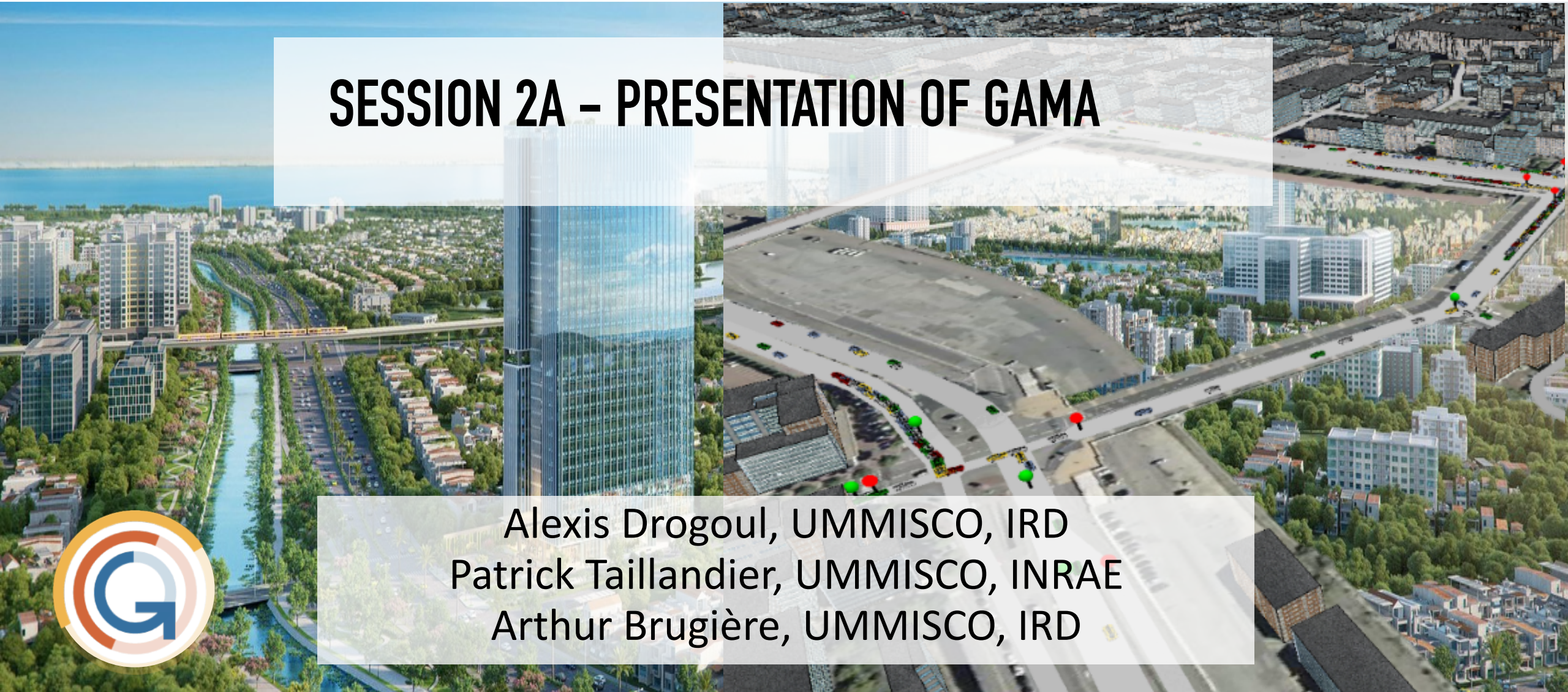
Institut de Recherche pour le Développement FRANCE
French National Research Institute for Sustainable Development

UMMISCO
Unité Mixte Internationale



SESSION 2A – PRESENTATION OF GAMA

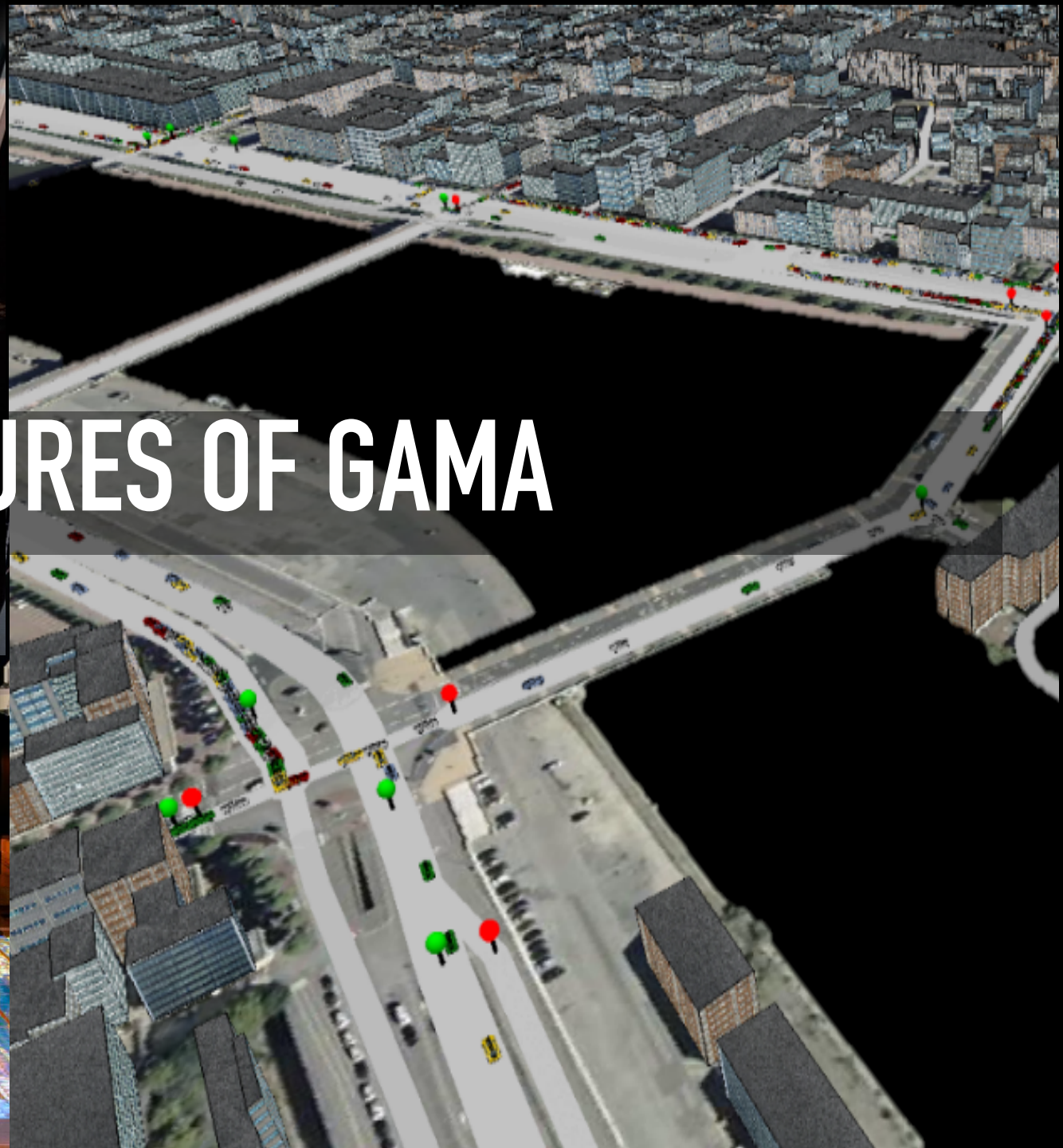
Alexis Drogoul, UMMISCO, IRD
Patrick Taillandier, UMMISCO, INRAE
Arthur Brugière, UMMISCO, IRD

GAMA, a platform dedicated to build spatially explicit agent-based models and run simulations

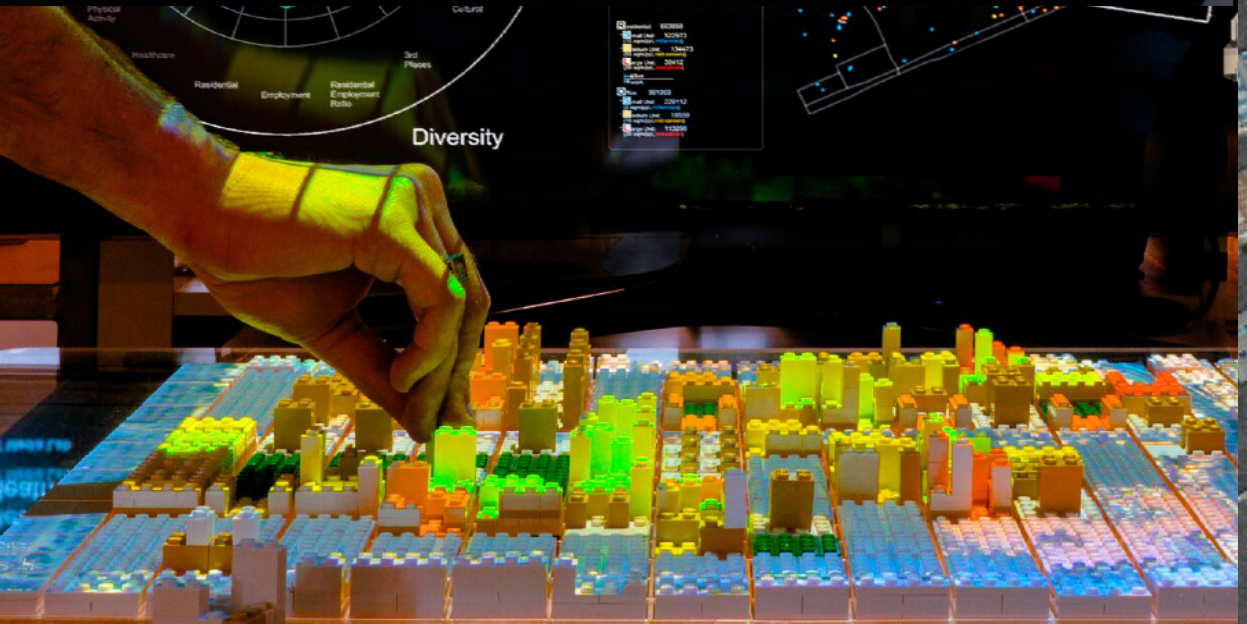
- Developed by a consortium of research team : UMMISCO (IRD - coordinator), ACROSS (Hanoi), DREAMS (Can Tho), UT1-IRIT (Toulouse), INRAE-MIAT (Toulouse), LRI (Orsay), MIT Media Lab (Boston)…
- **Generic**: can be used for a wide range of applications
- Developed under GPL license: **open-source** (GNU v3)
- Allows **modelers** (even non computer-scientists) to build complex models **quickly and easily**:
  - Integrates a complete modeling language (**GAML**) and
  - an I**ntegrated Development Environment**
- Developed in **JAVA : easy to extend** in order to take specific needs into account

GAMA overview: strength of GAMA

- Powerful modeling language with a simple syntax and numerous built-in operators
- Modern IDE
- Seamless integration of geographic data and GIS tools with agent-based models
- Supports the development of complex models with thousands of agents and rich behaviors
- Integrates powerful visualisation tools



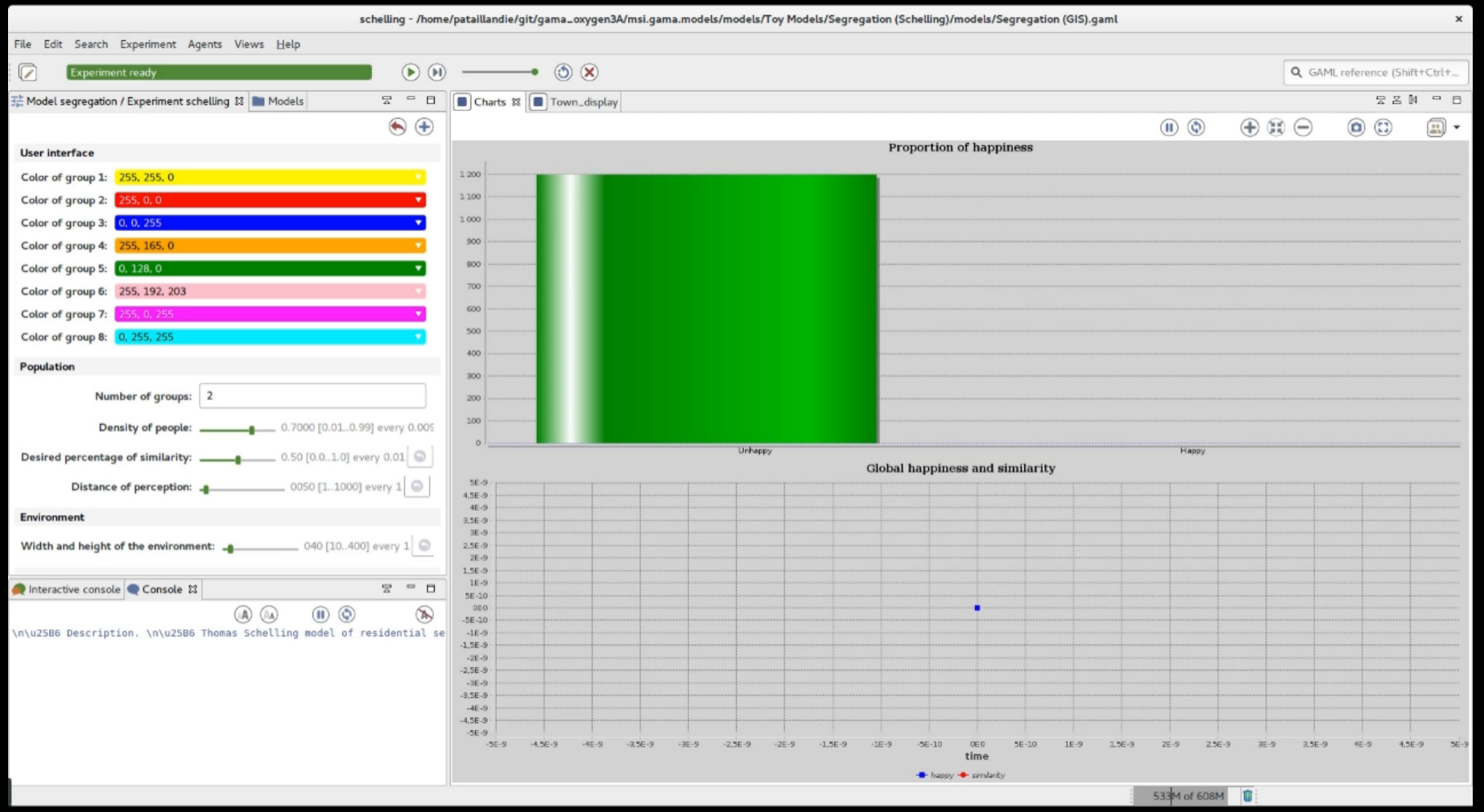
MAIN FEATURES OF GAMA



GAMA provides a complete Integrated Development environment (IDE) to build models

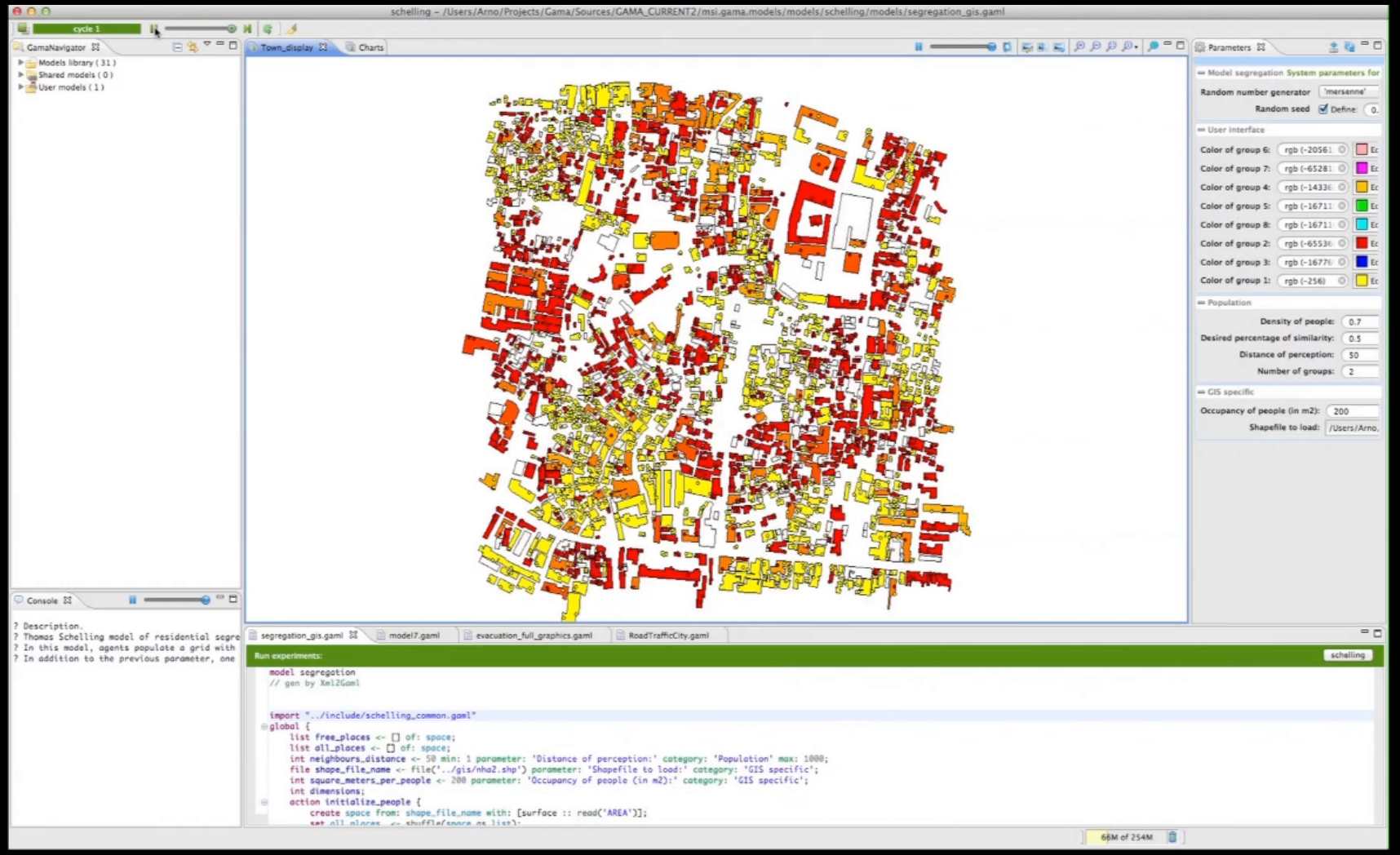
Dedicated modeling Language (GAML), easy to learn and to extend

GAMA provides a modern and flexible modeling and simulation interface



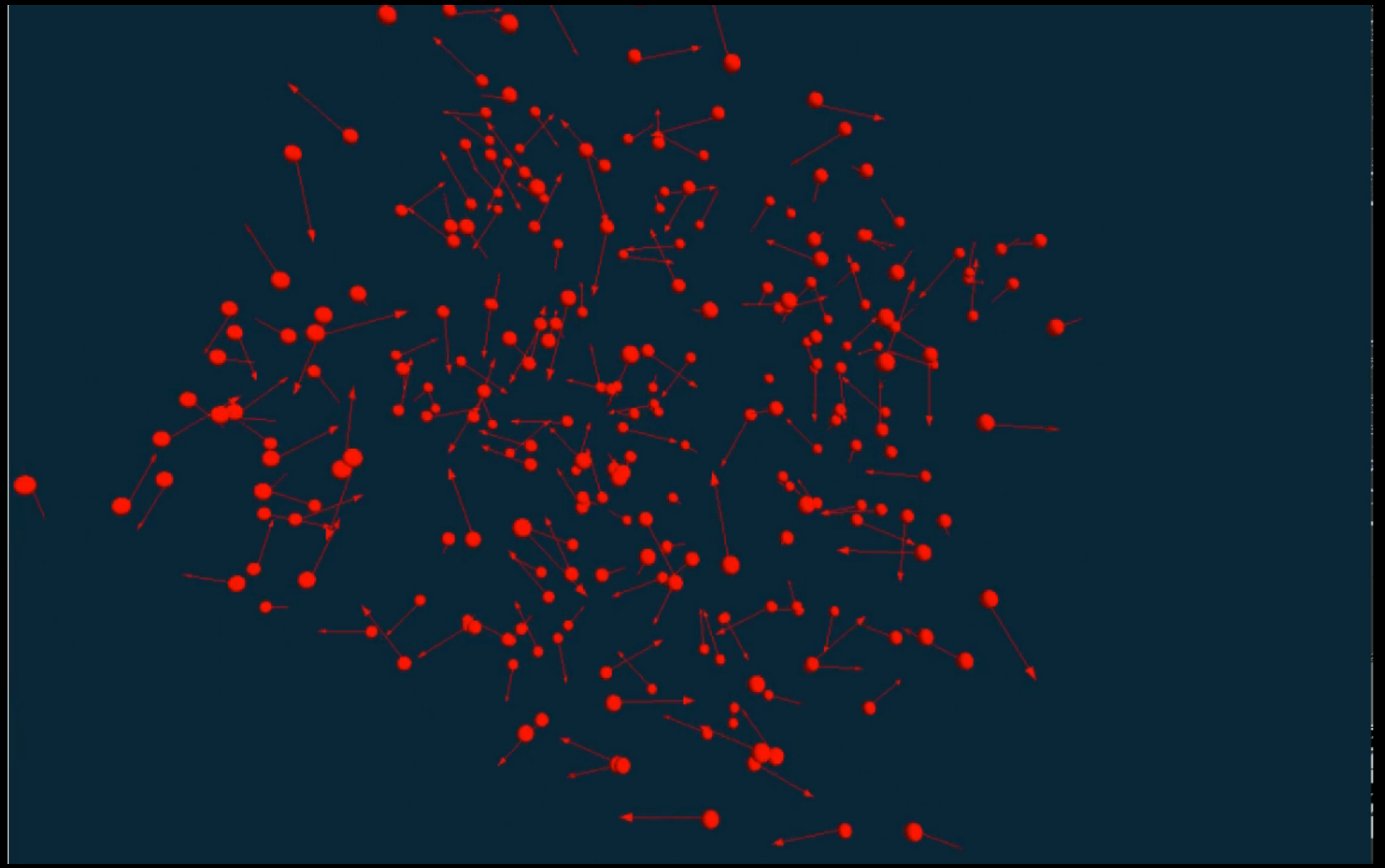
Panel control, agent inspector and browser, data viewers, integrated documentation

Easy integration of GIS data, powerful features to manage GIS data (many spatial operators)



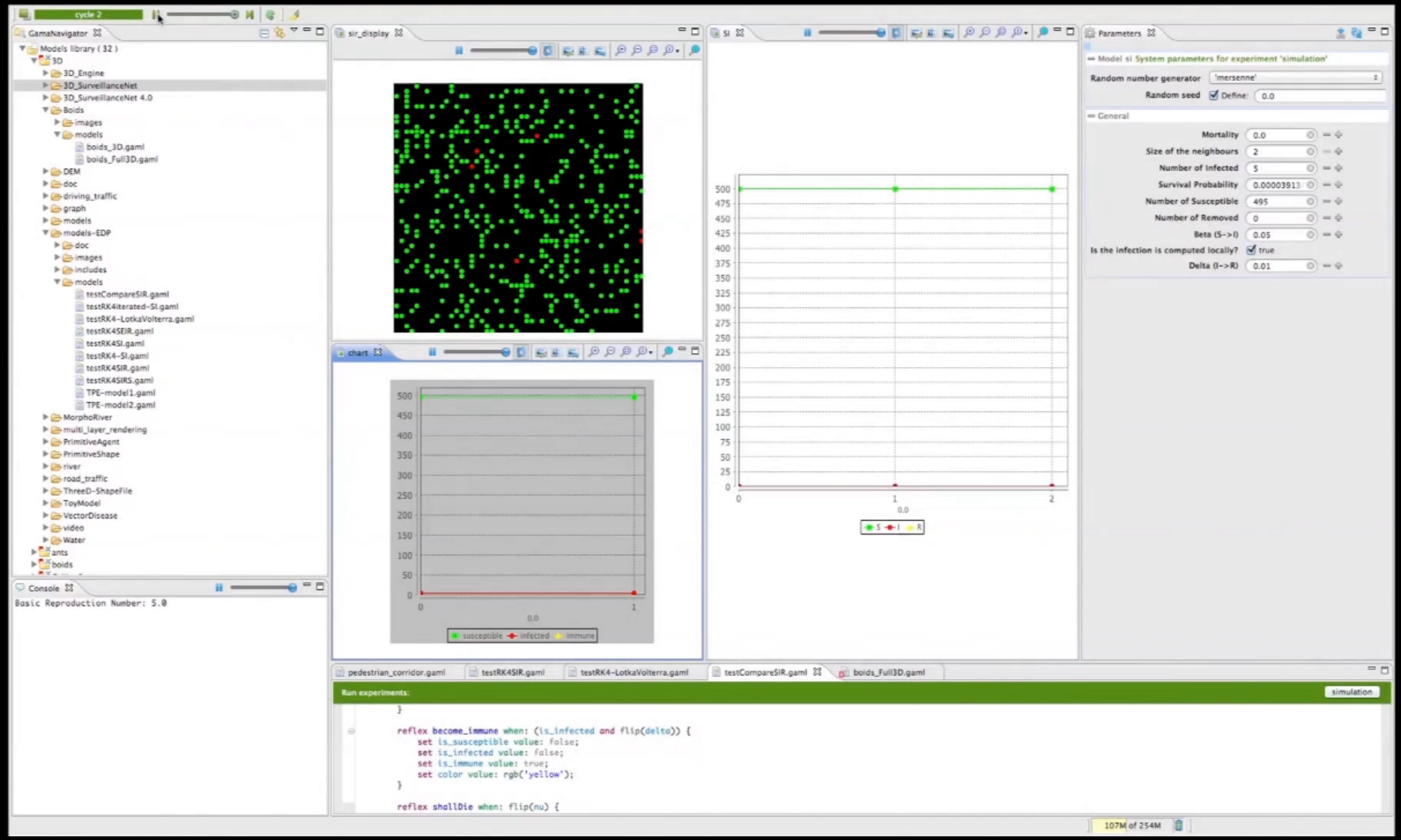
Transparent agentification of 2D/3D GIS data (shapefiles, OSM, asc) powerful geometrical operations (union, difference, spatial queries....) , export into Shapefile/asc/geotiff/KML

Many optimized operators dedicated to agent movement and perception on continuous, grid and graph topologies



Many integrated algorithms: Dijkstra, Floyd Warshall, A*, NBA*, JSP (grid)…

Allows to use different formalisms to define agent behaviors



Differential equations, BDI architecture, Finite state machine, Reflexes, ...

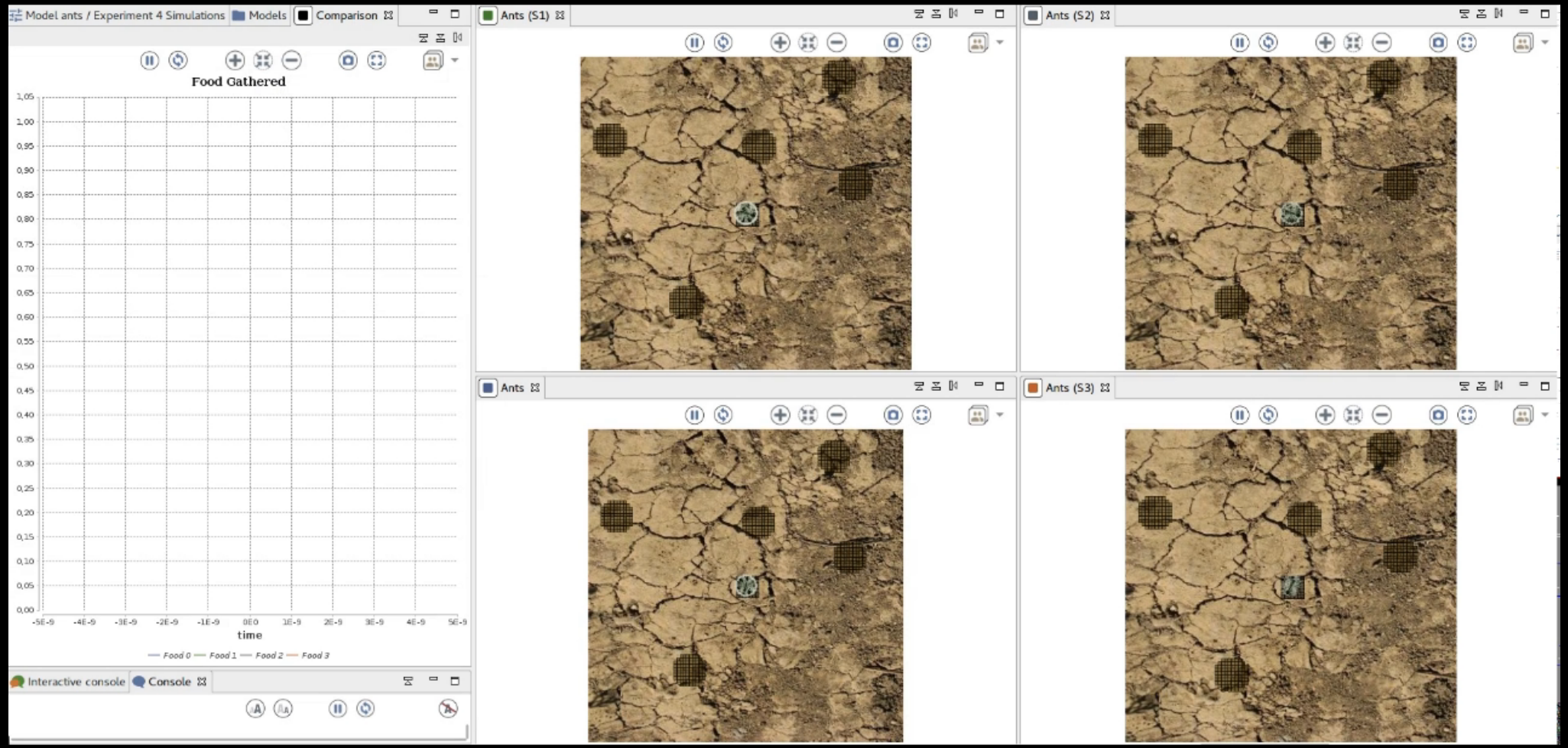
Powerful visualization tools allowing to define as many displays as necessary

3D display, use of layers, Chart Display....

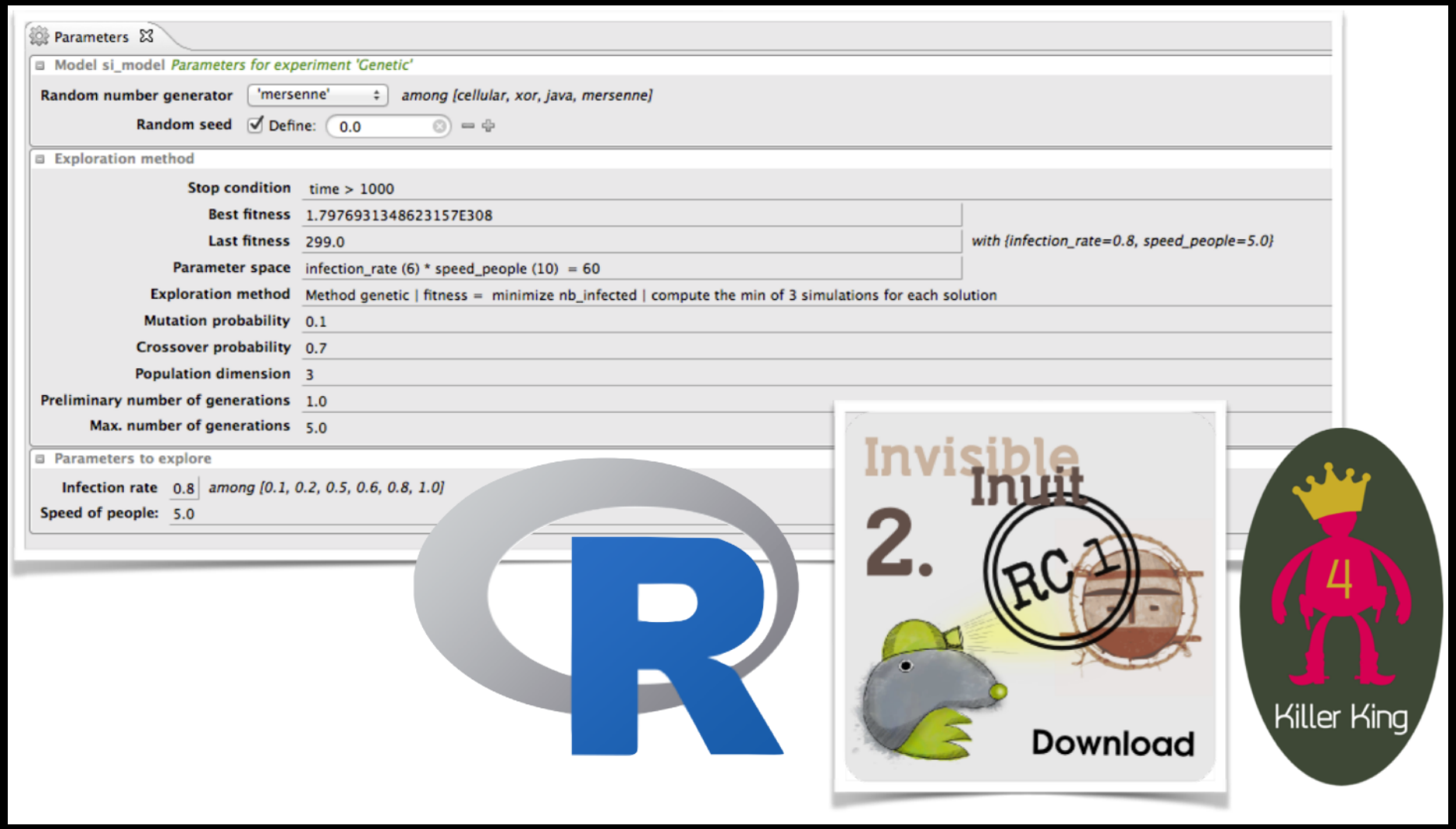
Powerful user-interaction tools allowing to interact with simulations

Event layers, user commands, simulation interconnection

Advanced features: multi-simulation, multi-level, co-modeling

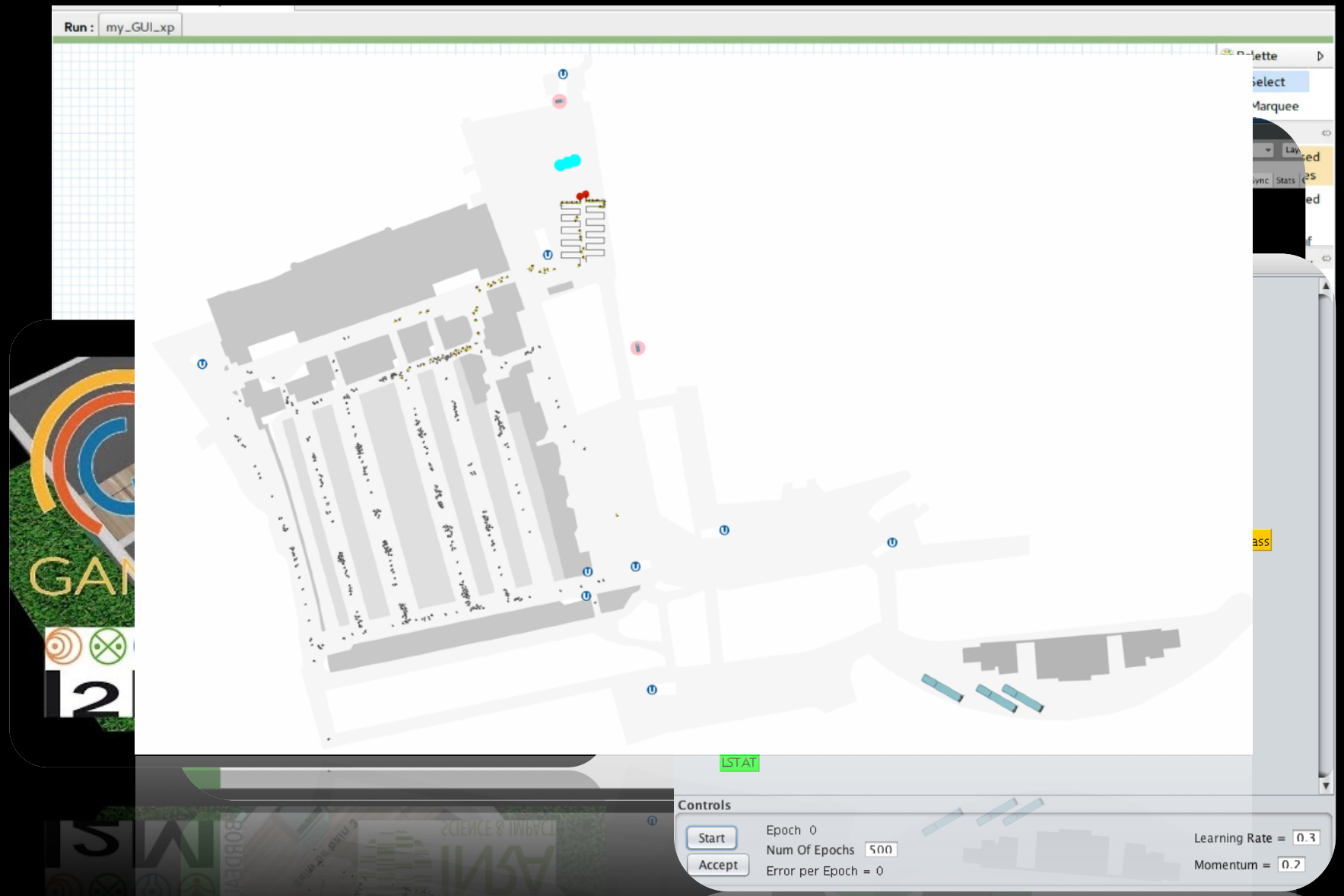


Model exploration and calibration



Integrated batch and Headless mode, connection with Python, R and OpenMole

Many extensions: graphical modeling, Unity 3D, machine learning….

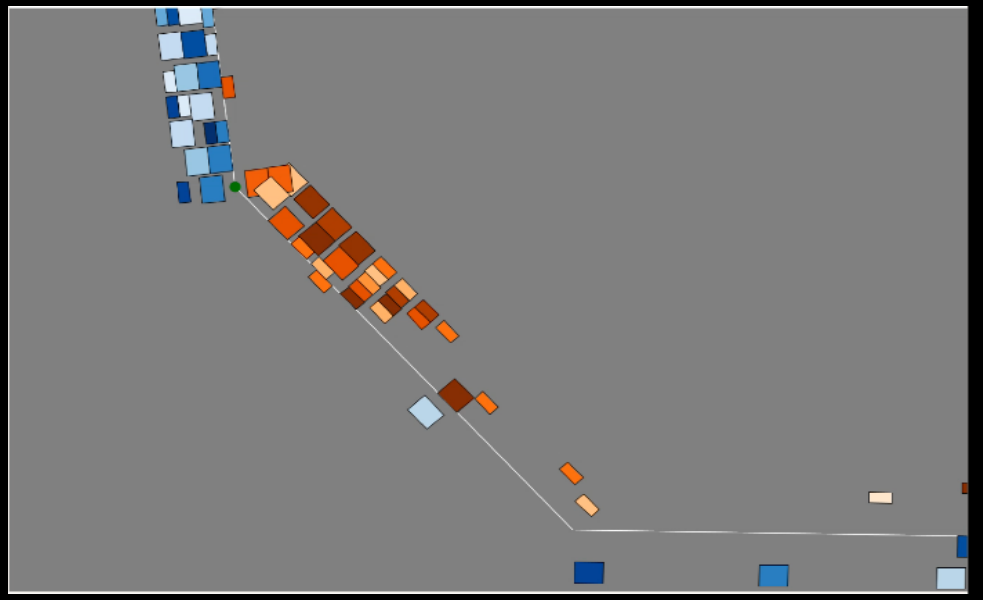


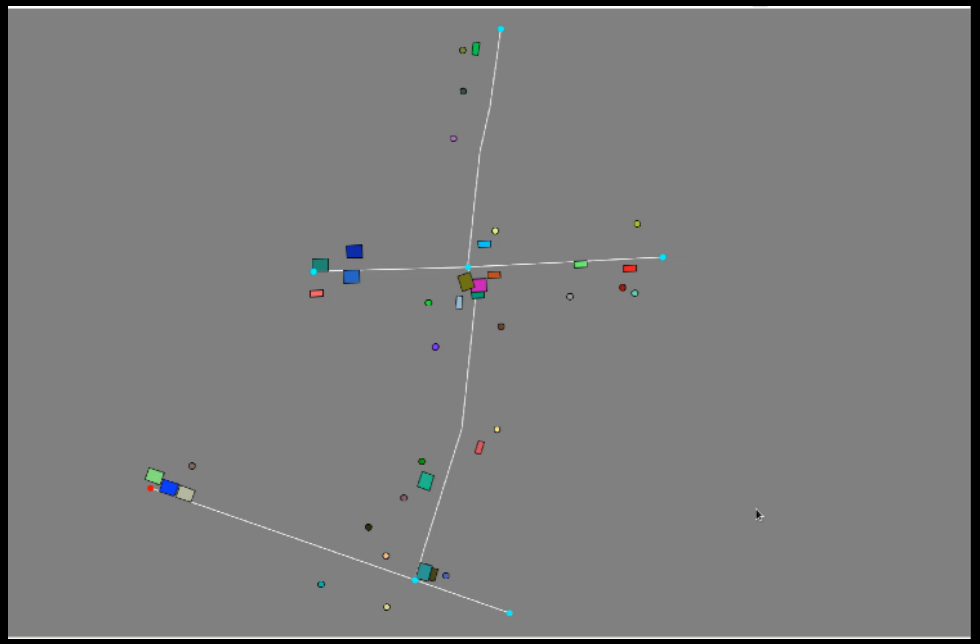
EXAMPLE OF APPLICATION: MOBILITIES & AIR POLLUTION

SIMULATING THE TRAFFIC IN VIETNAM

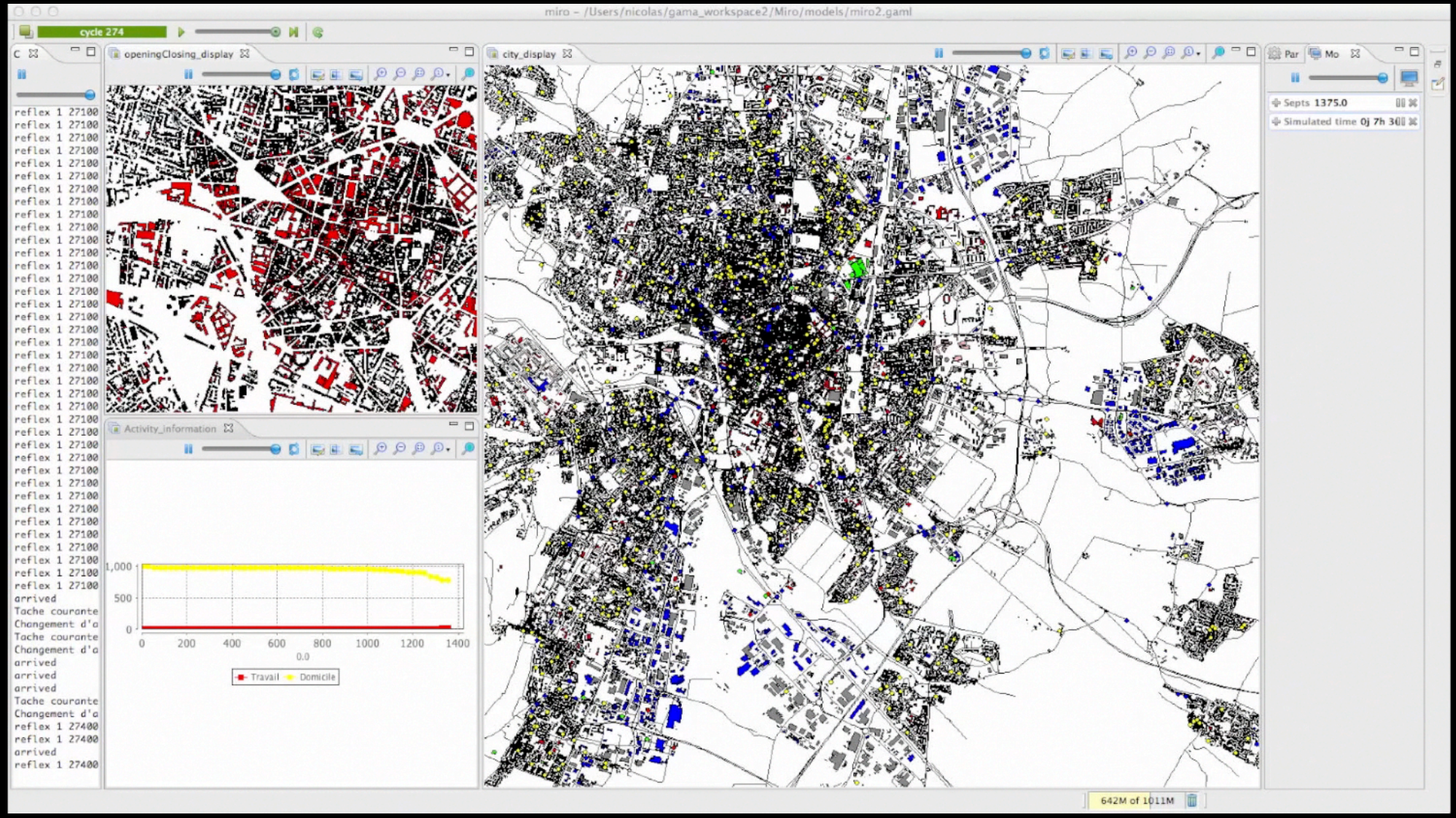
Traffic in HCM/Hanoi (data from 2017) :

- ✓ 74% de motos
- ✓ 19% de vélos
- ✓ 6% de piétons
- ✓ 1% de voitures

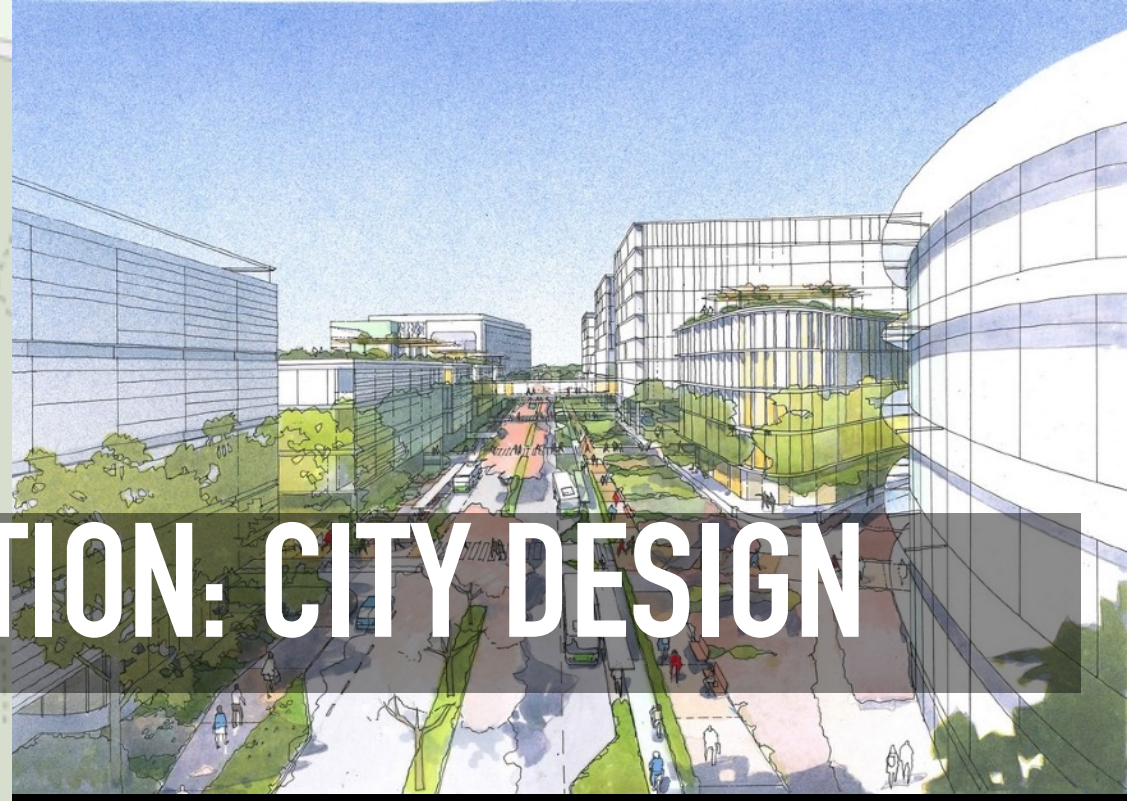




MIRO2 PROJECT: how to improve individual accessibility to the city in order to better manage urban mobility?



EXAMPLE OF APPLICATION: CITY DESIGN



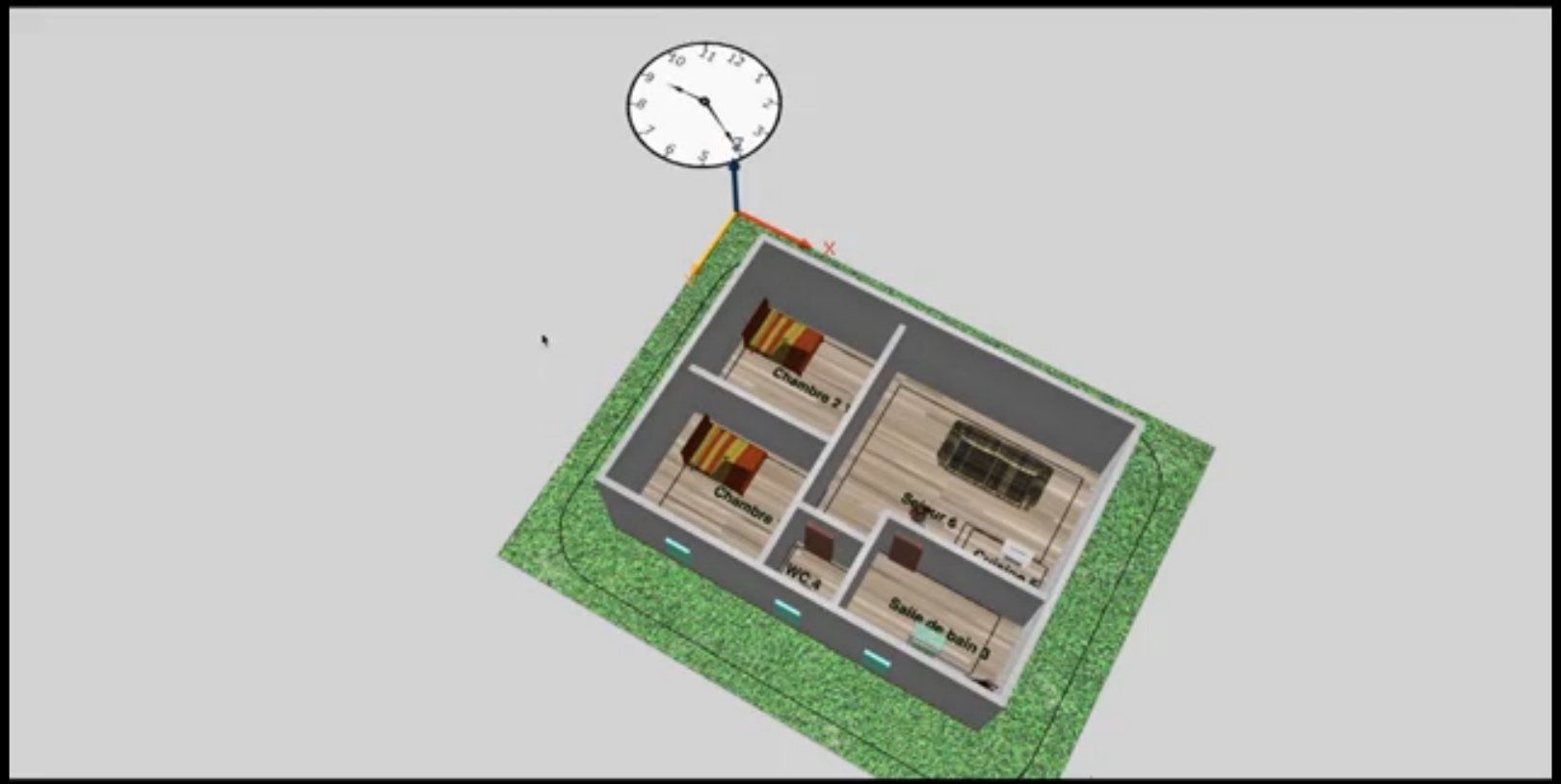
CITYSCOPE CHAMPS-ELYSEES (PARIS, FRANCE)

CITYSCOPE VOLPE

Alonso, L., Zhang, Y. R., Grignard, A., Noyman, A., Sakai, Y., ElKatsha, M., ... & Larson, K. (2018, July). Cityscope: a data-driven interactive simulation tool for urban design. Use case volpe. In *International conference on complex systems* (pp. 253-261). Springer, Cham.

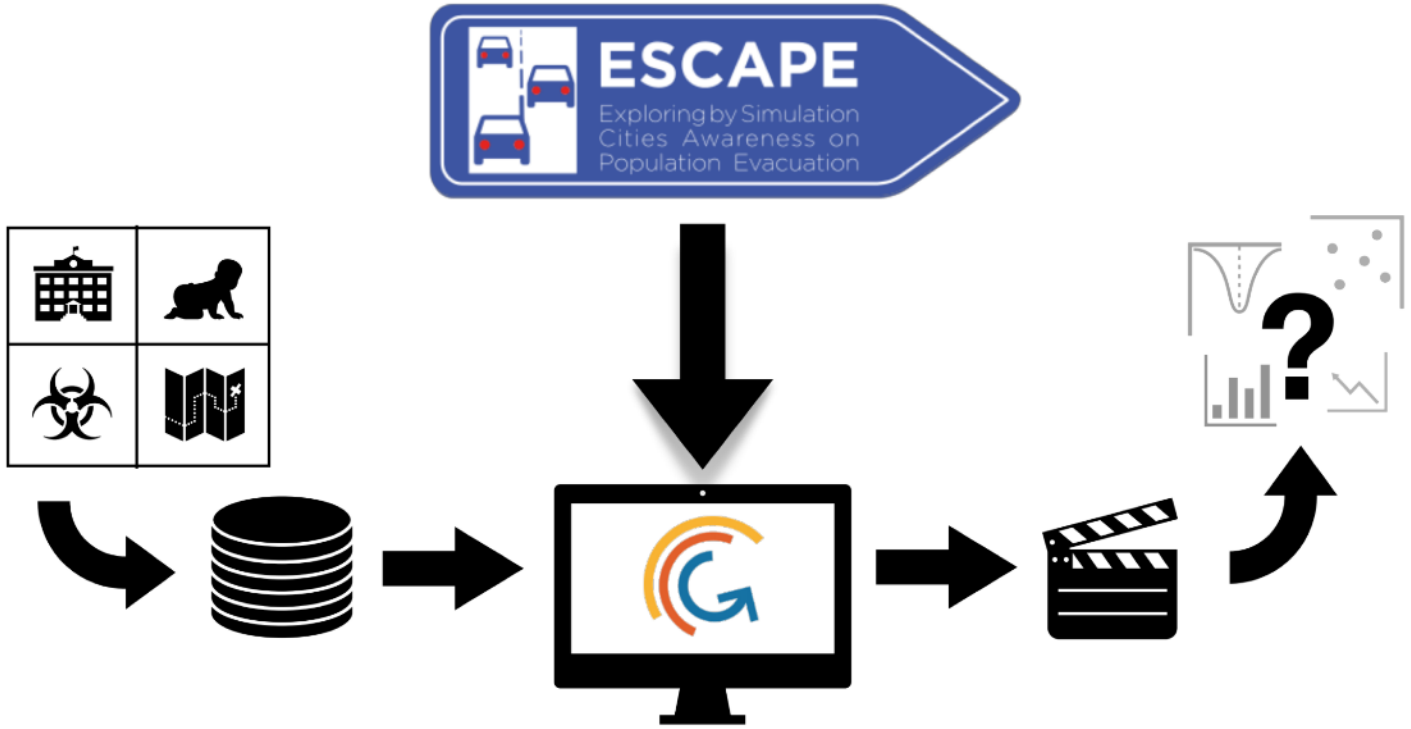
https://www.media.mit.edu/projects/cityscope/overview/

LI-BIM: Simulation of the behavior of the occupants in a building and their indoor comfort



Micolier, A., Taillandier, F., Taillandier, P., & Bos, F. (2019). Li-BIM, an agent-based approach to simulate occupant-building interaction from the Building-Information Modelling. *Engineering Applications of Artificial Intelligence*, *82*, 44-59.

EXAMPLE OF APPLICATION: RISK MANAGEMENT



Objective: test prevention plans through simulation

PROJET FINANCÉ PAR L'ANR - PROJECT FUNDED BY THE ANR
ANR

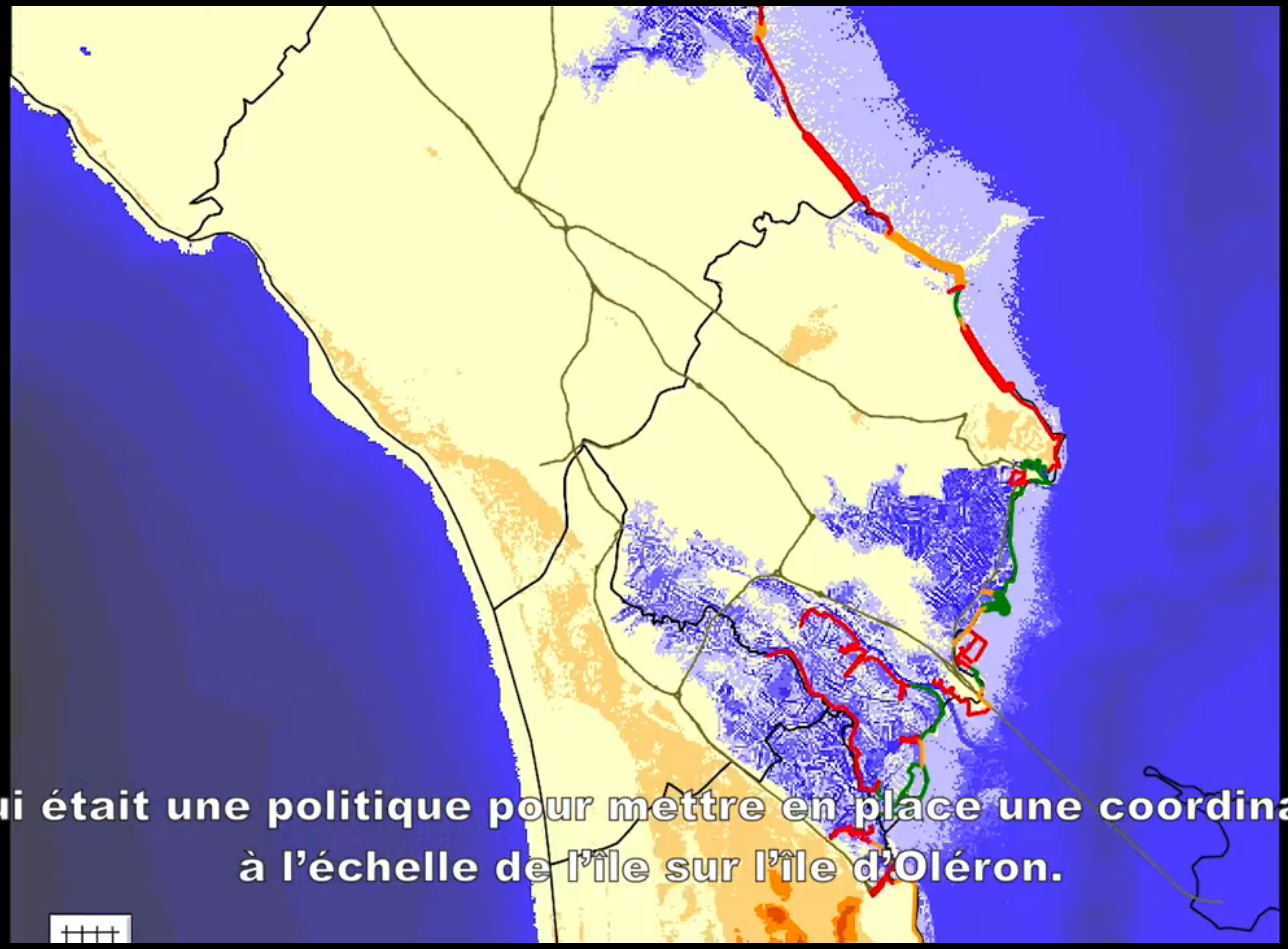
APPLICATION EXAMPLE: SAUMUR (France)

Flooding of the Loire river with the sudden formation of a breach in the dike on the right bank, protecting part of the city of Saumur and neighboring towns located at the foot of the hillside (Authion valley)

Daudé, E., Chapuis, K., Taillandier, P., Tranouez, P., Caron, C., Drogoul, A., ... & Zucker, J. D. (2019, May). ESCAPE: exploring by simulation cities awareness on population evacuation. In *ISCRAM*.

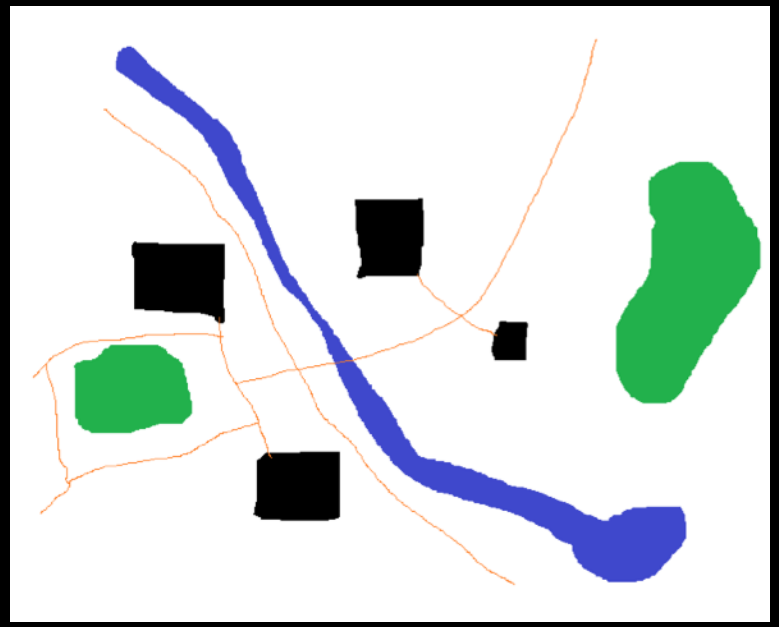
LITTOSIM: A MULTI-PLAYER SERIOUS GAME

LITTOSIM :
Participatory simulation of coastal flooding - building social learning on prevention measures
with decision-makers

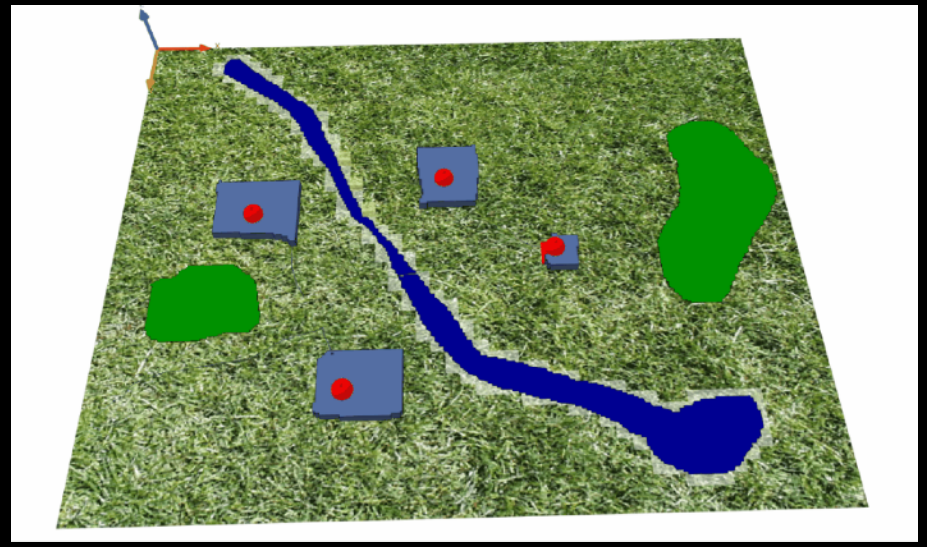


DYCOMA: THE DYNAMIC MIND MAP AS AN AID TO REFLECTION ON FLOODING IN THE CITY

Objectives : allow to understand the participants' representation of the territory, to put it in comparison with the flood risk and allows them to think about the impact of urban planning choices and flood management strategies (grey solutions, nature-based solutions...).

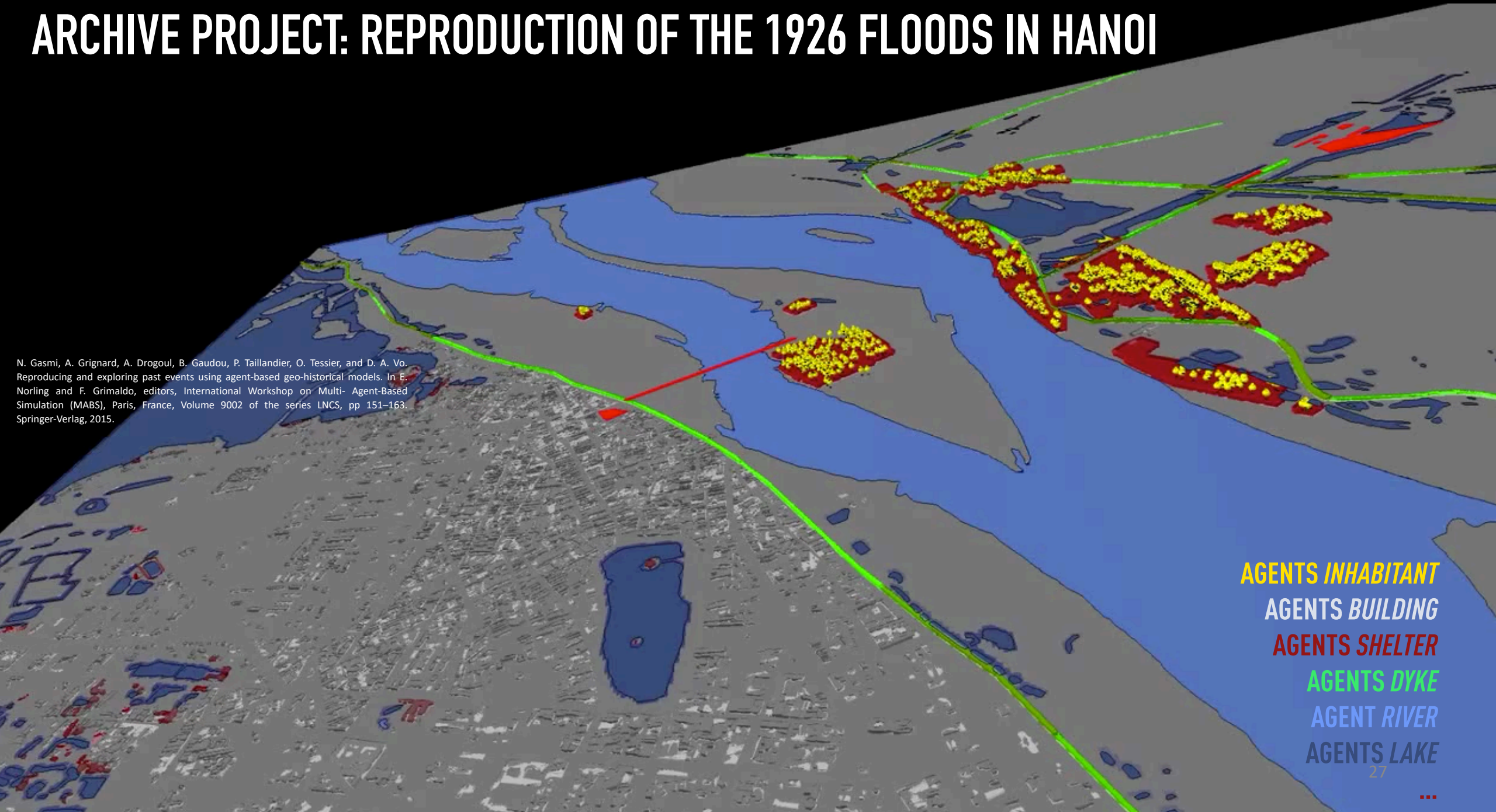


We ask people to draw their environment



From the digitalized version of the drawing, we simulate a flood

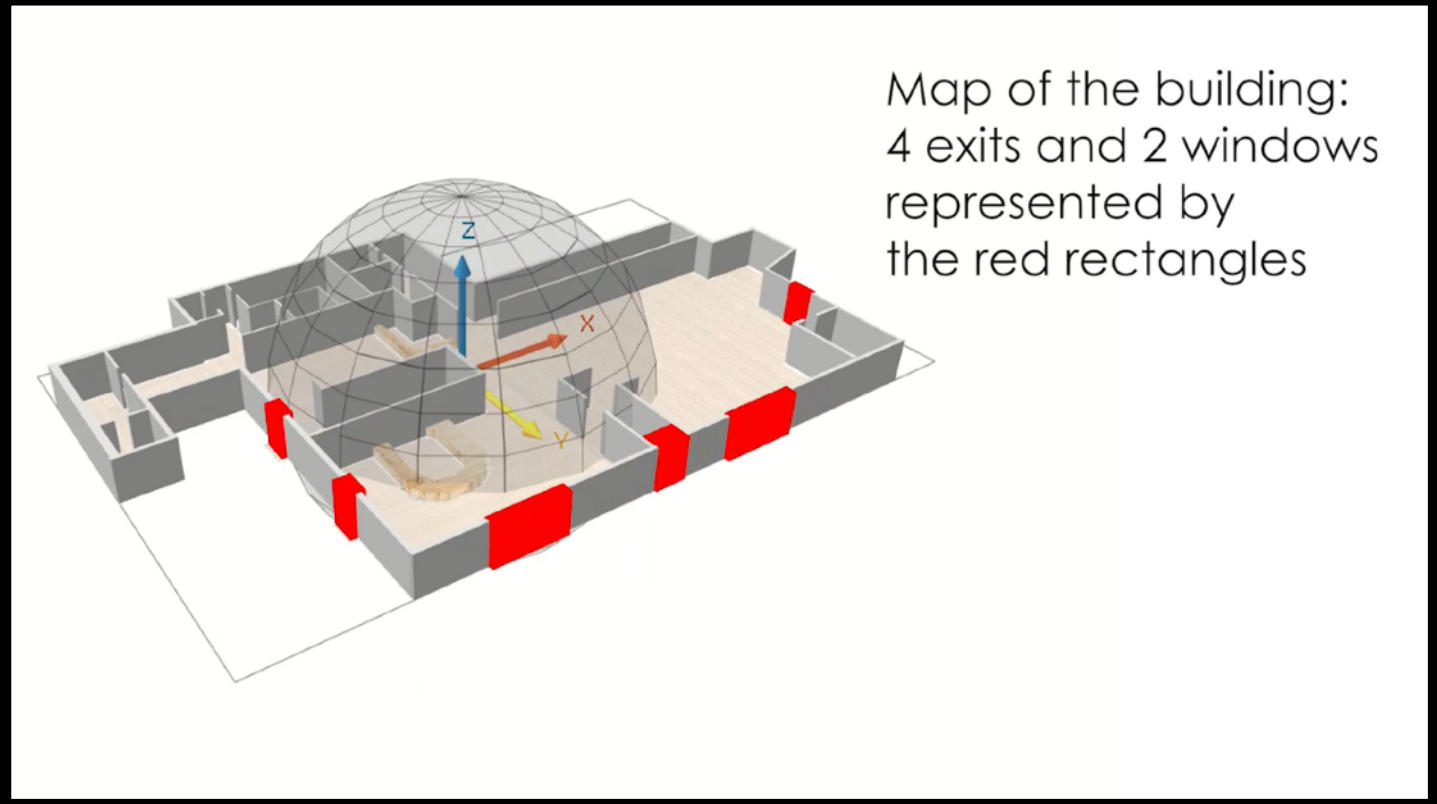
ARCHIVE PROJECT: REPRODUCTION OF THE 1926 FLOODS IN HANOI



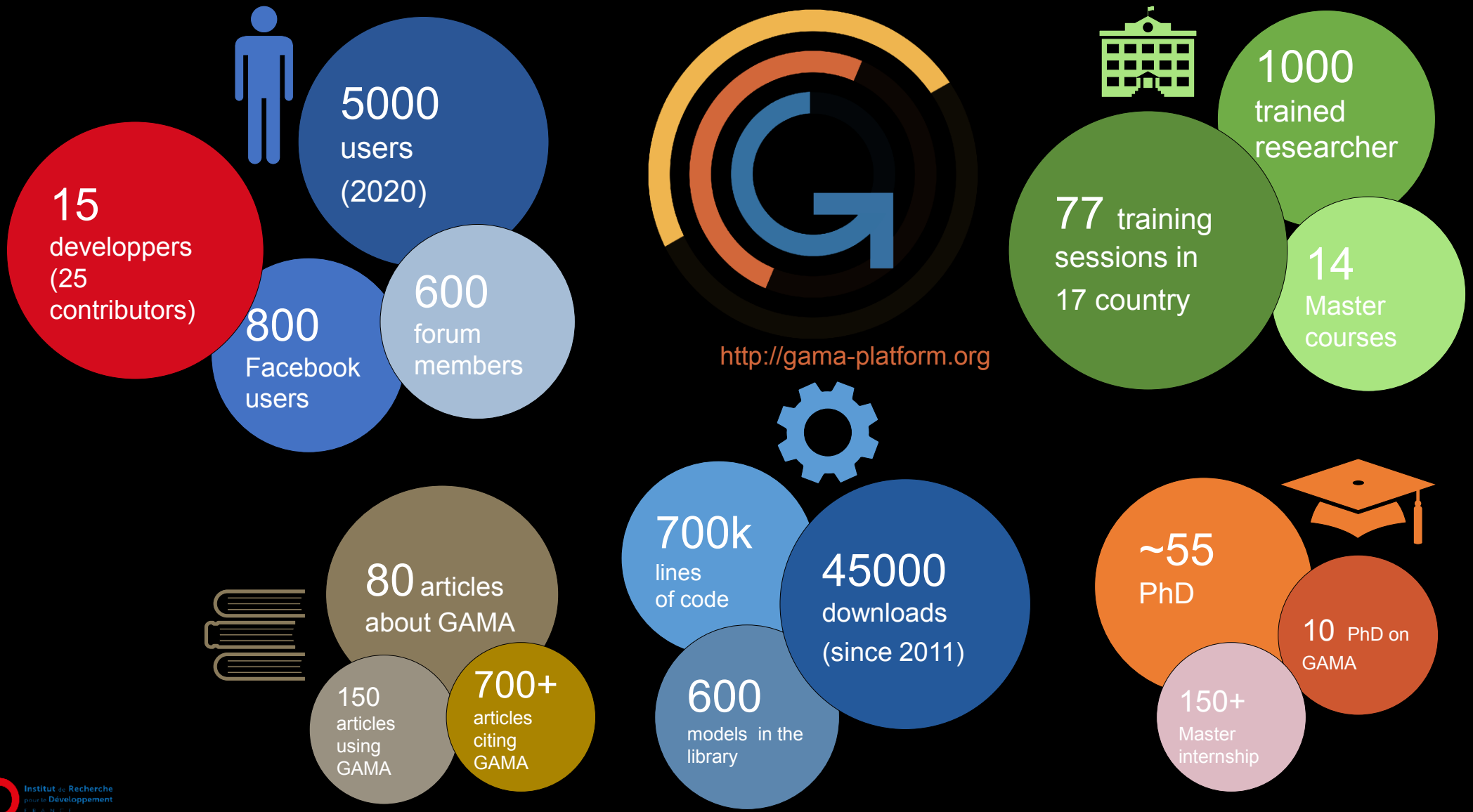
N. Gasmi, A. Grignard, A. Drogoul, B. Gaudou, P. Taillandier, O. Tessier, and D. A. Vo. Reproducing and exploring past events using agent-based geo-historical models. In E. Norling and F. Grimaldo, editors, International Workshop on Multi- Agent-Based Simulation (MABS), Paris, France, Volume 9002 of the series LNCS, pp 151–163. Springer-Verlag, 2015.

ACTEUR PROJECT: Building evacuation in crisis context

Valette, M., Gaudou, B., Longin, D., & Taillandier, P. (2018, October). Modeling a Real-Case Situation of Egress Using BDI Agents with Emotions and Social Skills. In *International Conference on Principles and Practice of Multi-Agent Systems*(pp. 3-18). Springer, Cham.



GAMA IN A FEW STATISTICS...



More information

- **Websites of the platform**

  http://gama-platform.org

  https://github.com/gama-platform/gama

- **Youtube Channel**: gama Modeling

  https://www.youtube.com/channel/ UCWJ1kWGDDI-9u2f2uD0gcaQ/feed

- **Social Network**: https://www.facebook.com/GamaPlatform

- **Mailing-lists**

  General mailing-list:

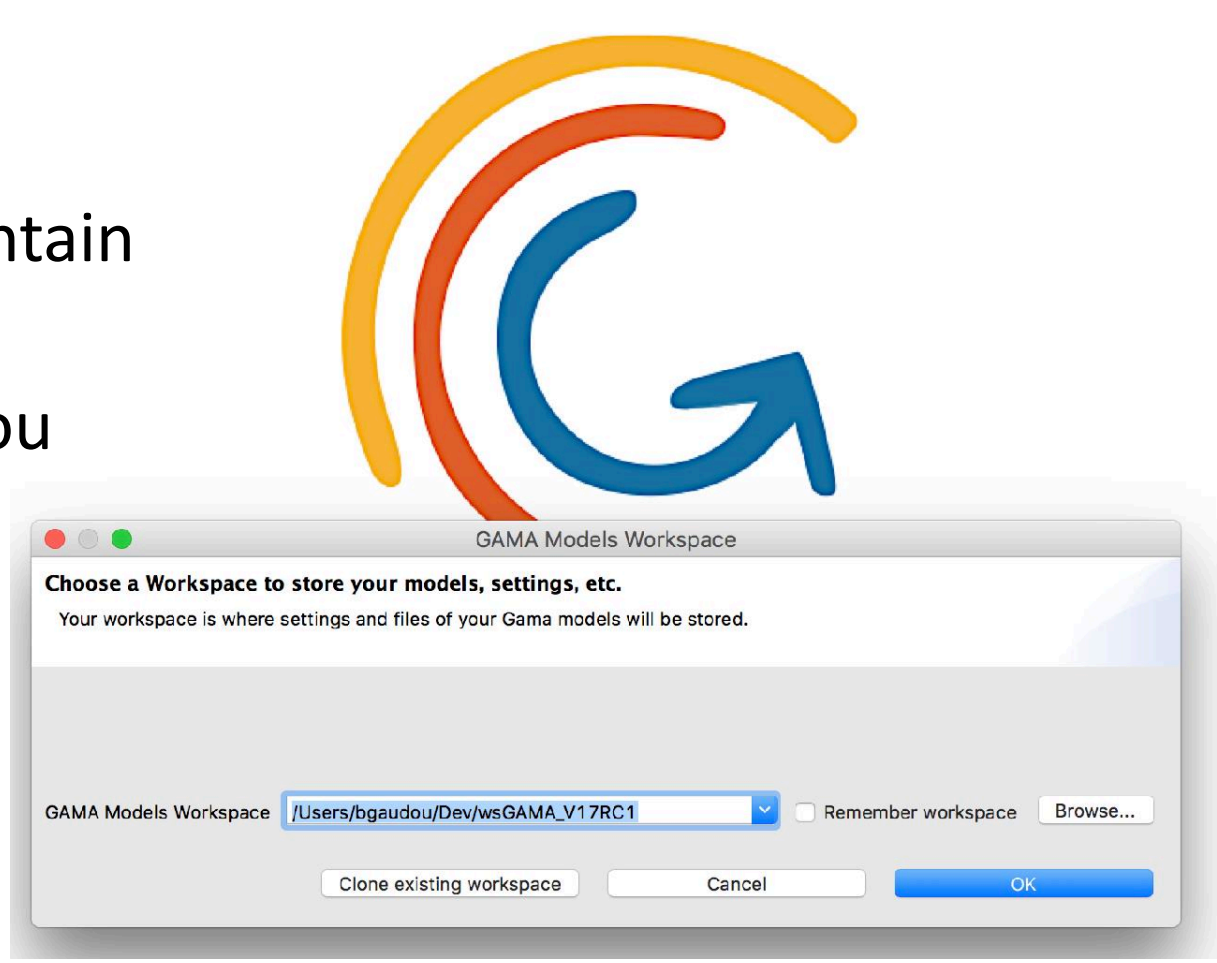
  https://groups.google.com/forum/?fromgroups#!forum/gama-platform

  Developers mailing-list:

  https://groups.google.com/forum/?fromgroups#!forum/gama-dev

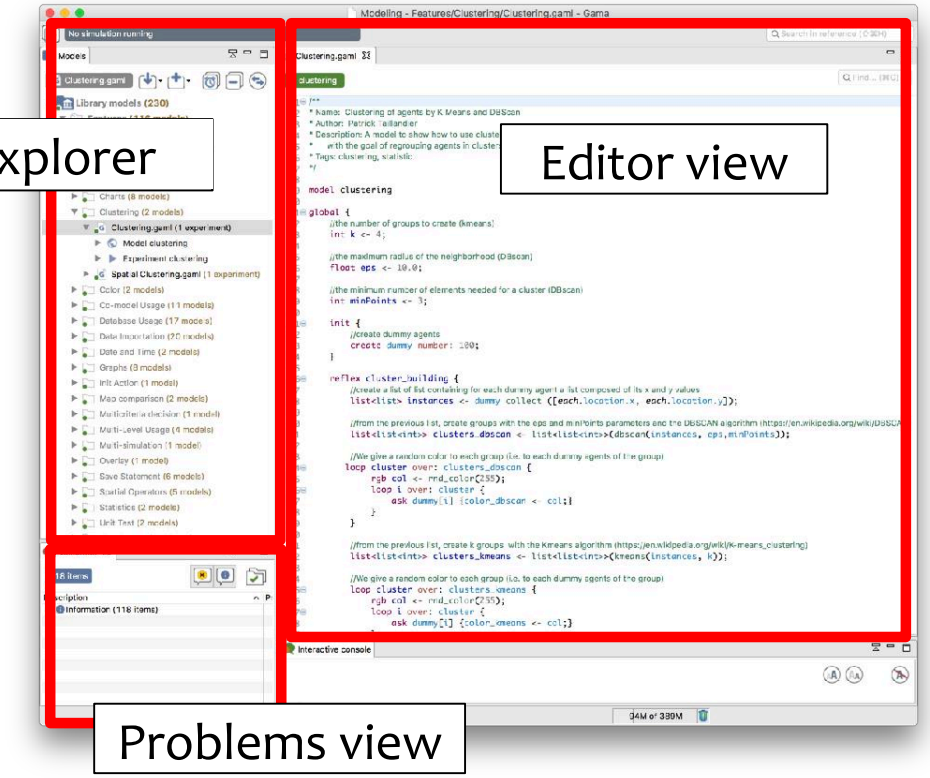
IT IS NOW TIME TO RUN GAMA !

- First GAMA asks you to choose a workspace.
- A workspace is a folder that will contain all your own projects and models.
- You are free to choose the folder you want!



GAMA MODEL FILES ARE STORED IN PROJECTS

- Each project may contain several models, as well as additional resources (GIS data, pictures,…).
- Belonging to the same project allows models to use each other and have access to the same resources.
- Projects can be organised in any way, although a default layout (“models”, “doc”, …) is proposed.



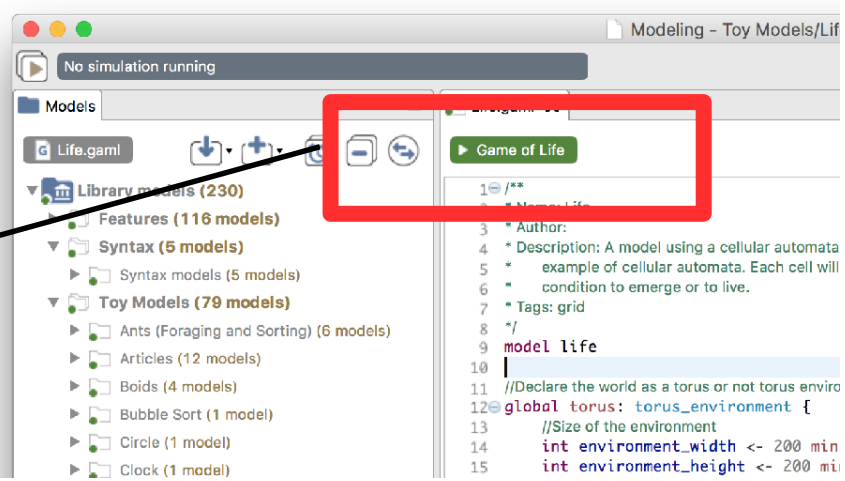
GAMA provides a library of models composed of 7 types of models:

- **Data**: simple models that show how manipulate data (importation, export, database…)
- **GAML Syntax**: models that present the syntax of the GAML language
- **Model Exploration**: models that show how (model calibration, multi-simulation…)
- **Modelling**: models that presents many modeling features of GAMA (spatial component, model coupling…)
- **Toy models**: classic agents-based models (ant models, boids, Schelling…)
- **Tutorials**: models linked to online tutorials
- **Visualization and User interaction**: models that show how to define visualizations and user-interactions

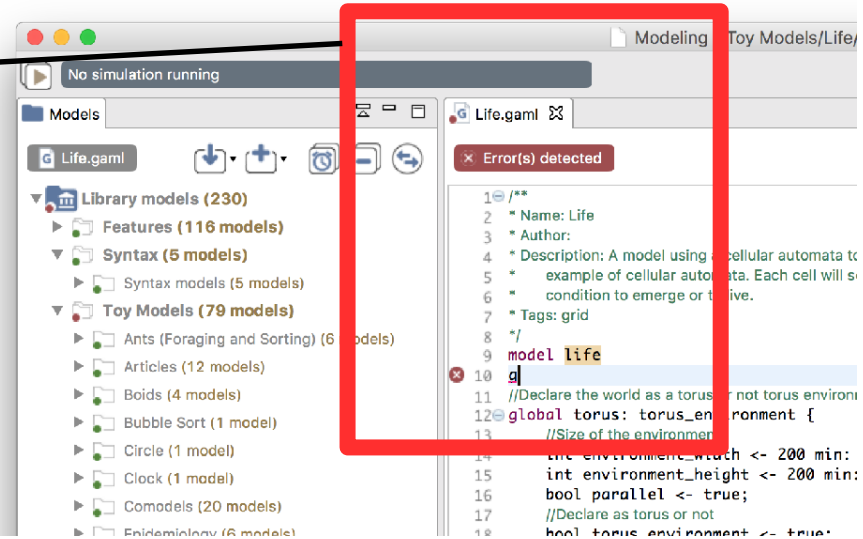
TAKE A LOOK AT "GAME OF LIFE" MODEL IN LIBRARY

- Models library \ Toy models \ Life \ Life.gaml

The model can be experimented

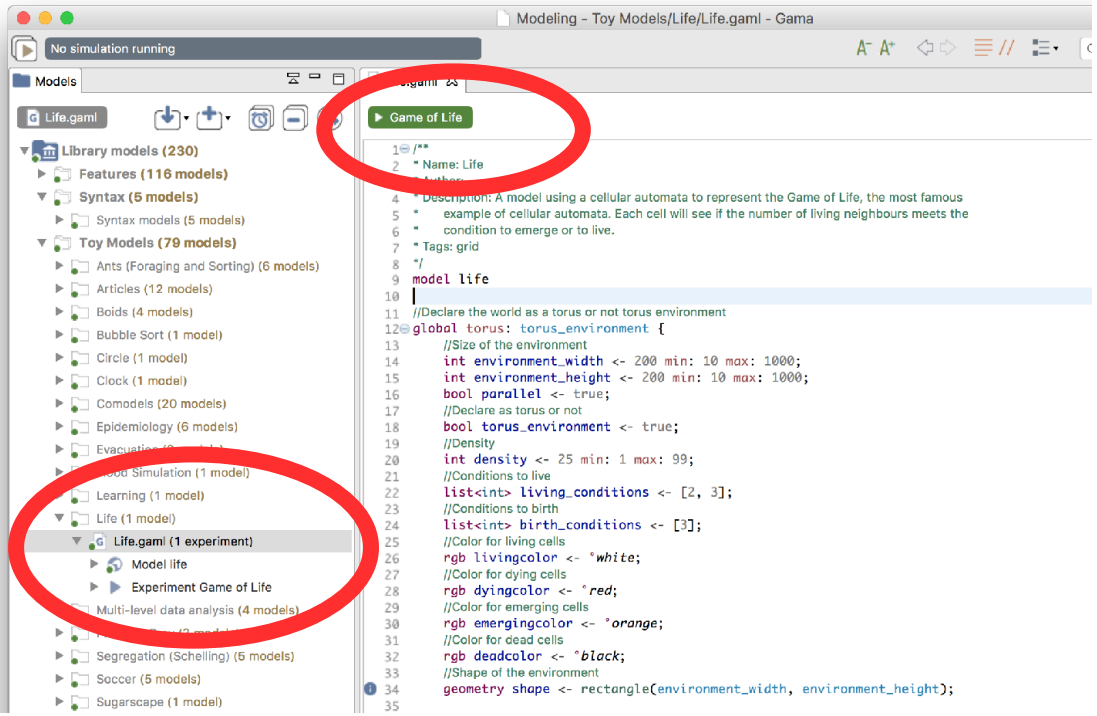


The model has errors



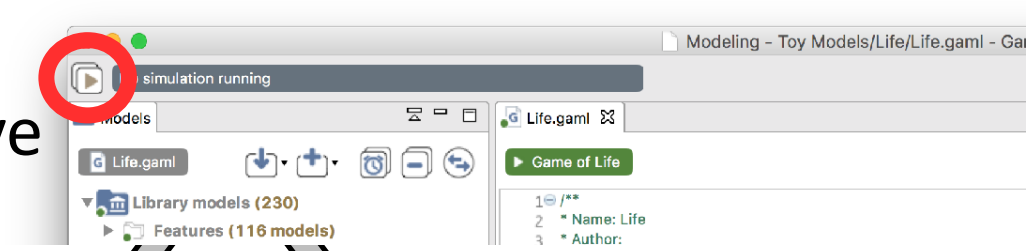
LAUNCH EXPERIMENT GAME OF LIFE

- An experiment is a way to “run” a model. It can be reached either by:
  - Clicking on an Experiment button
  - in the Project Explorer, under the name of the model

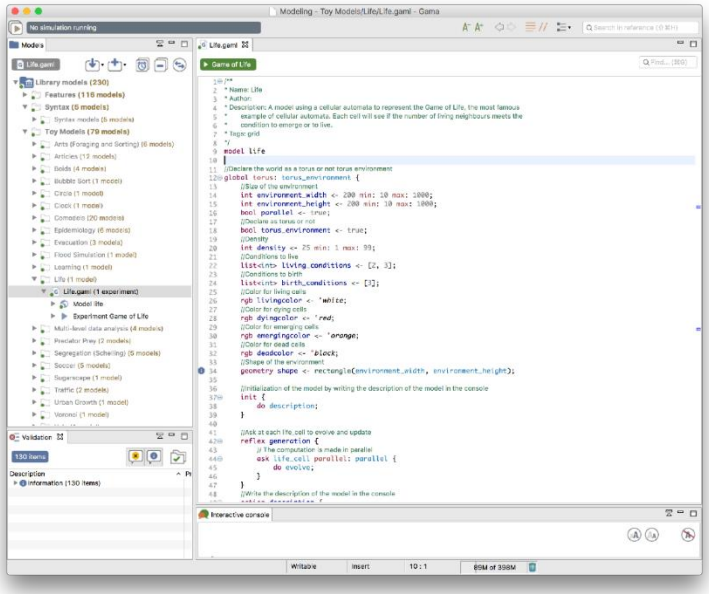


Launching an experiment will switch from *Modelling* to *Simulation* Perspective

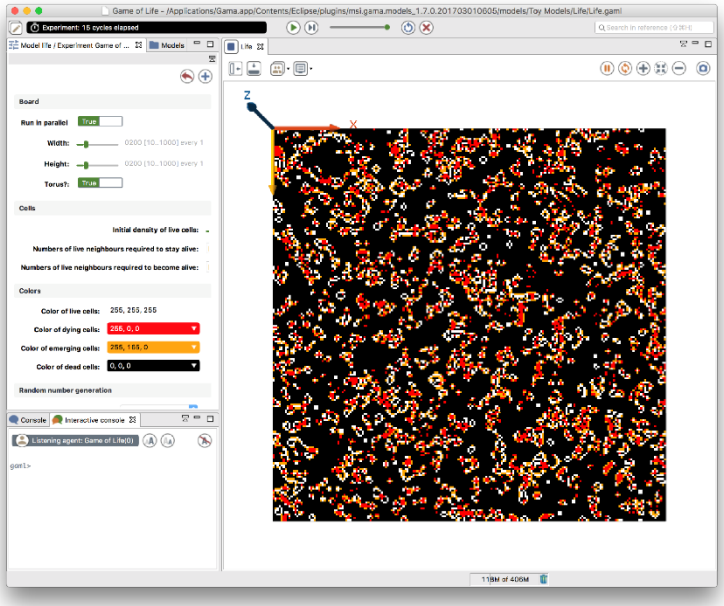
- Allows to change perspective



Modelling perspective

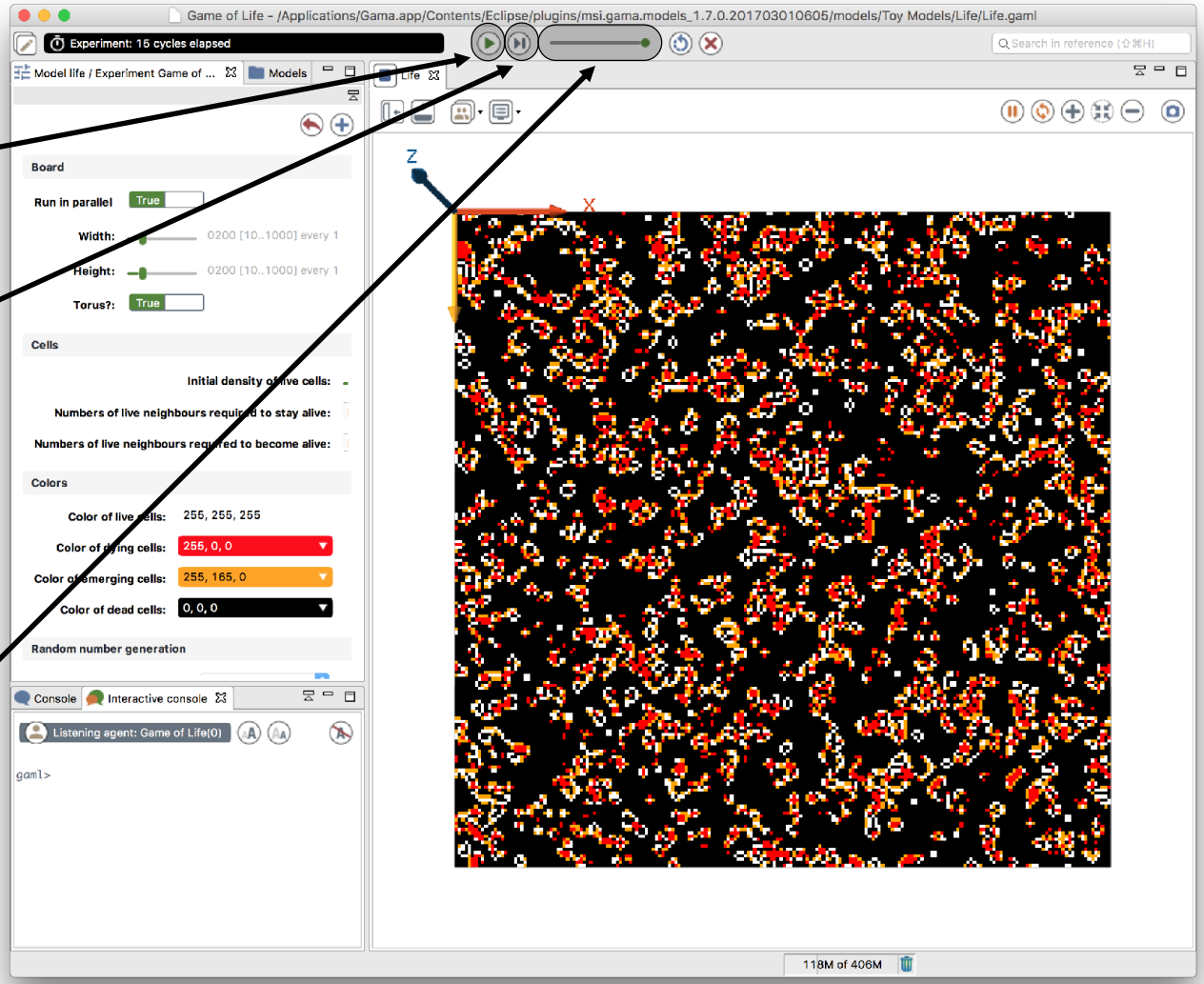


Simulation perspective



EXPLORING THE SIMULATION PERSPECTIVE

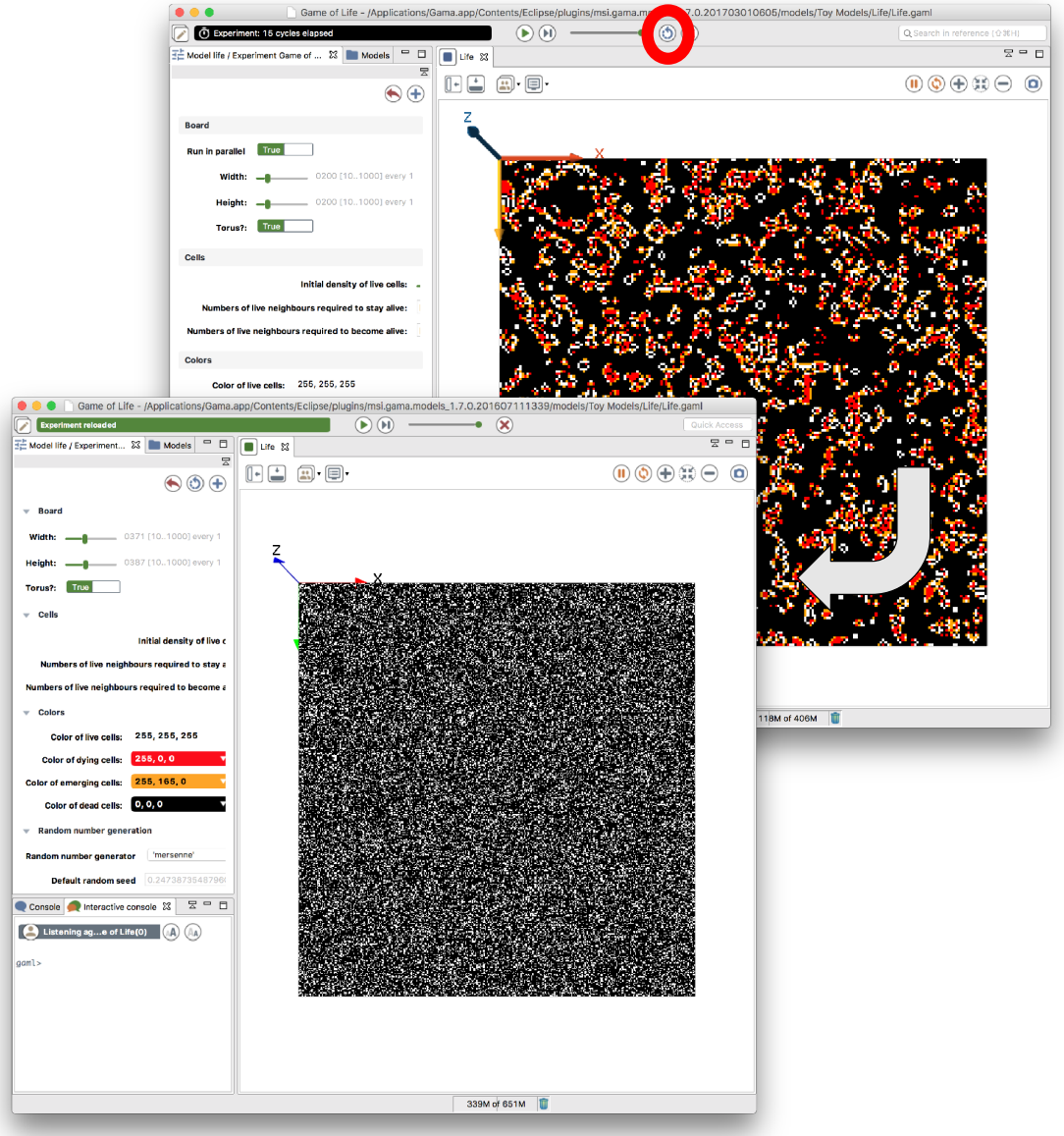
- Start/pause simulation (it will run until pause is clicked again)
- Step the simulation (it will run one cycle of the simulation)
- Adjust the speed of the simulation



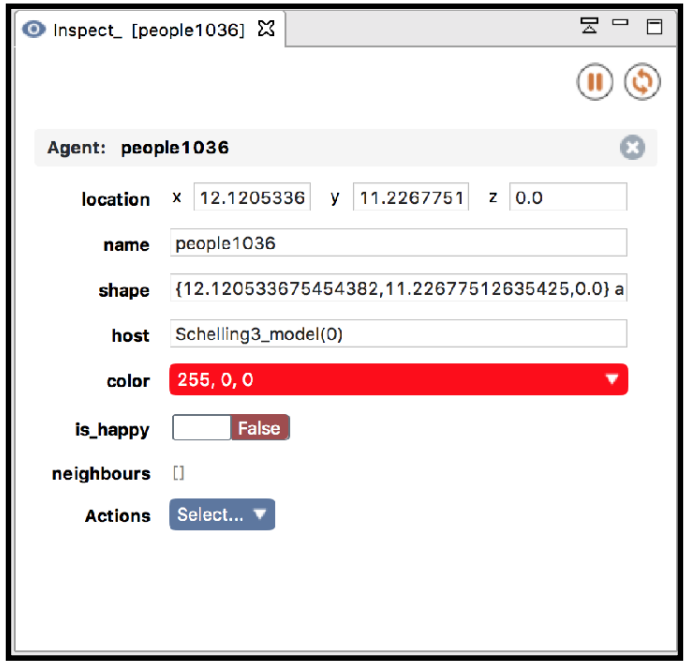
EXPLORE THE SIMULATION WITH PARAMETERS MODIFIED FROM PARAMETERS VIEW

- The modifications made to the parameters are either:
  - Used for the current simulation when it makes sense (for instance, if the user changes a color)
  - Used when the user reloads the experiment otherwise (for instance, if the user changes the size of the grid)

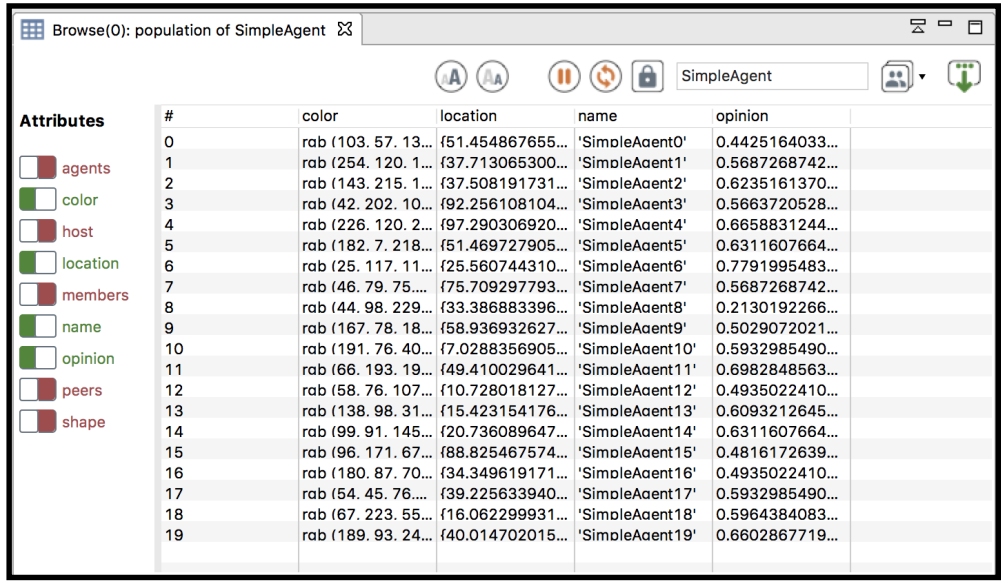
- Launching experiment again (from the model editor) will erase the modifications.



GAMA OFFERS 2 VIEWS THAT DISPLAY INFORMATION ABOUT ONE OR SEVERAL AGENTS



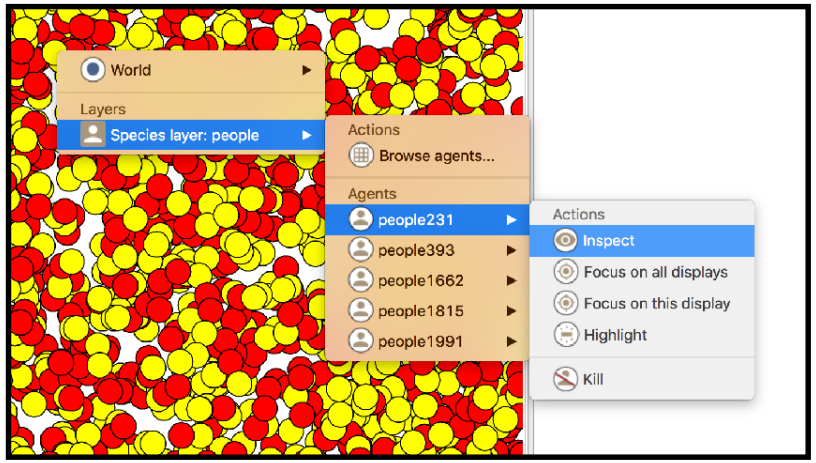
agent inspector

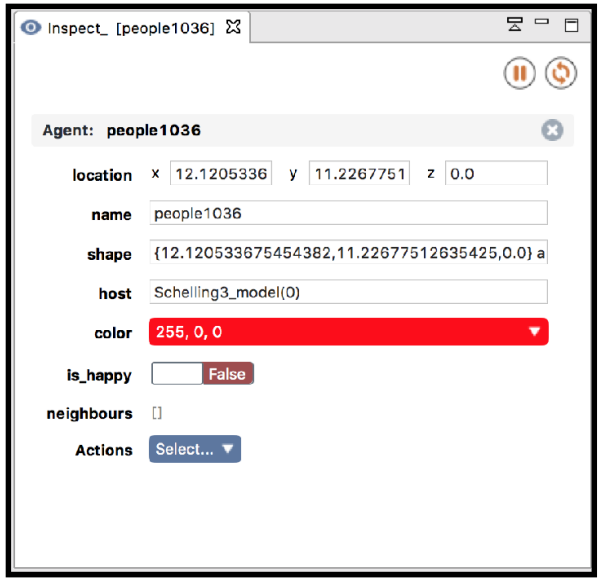


agent browser

INSPECT BY RIGHT CLICKING ON A AGENT IN A DISPLAY

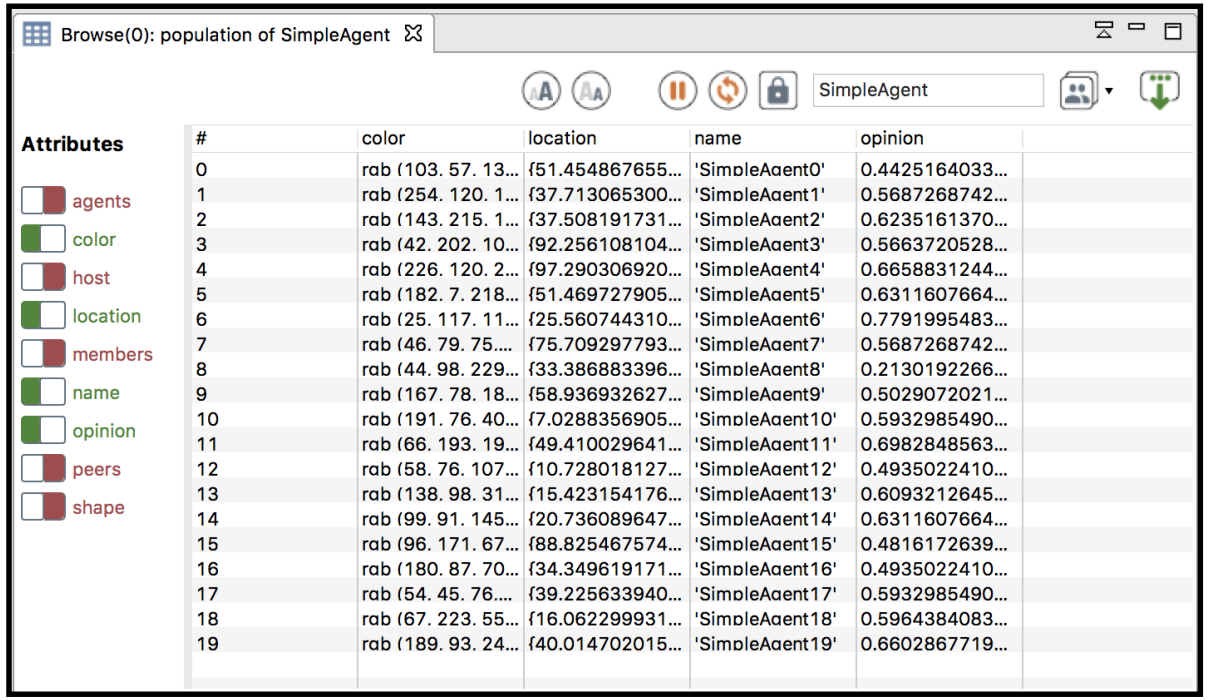
- provides information about one specific agent. It also allows to change the values of its variables during the simulation.
- It is possible to «highlight» the selected agent.



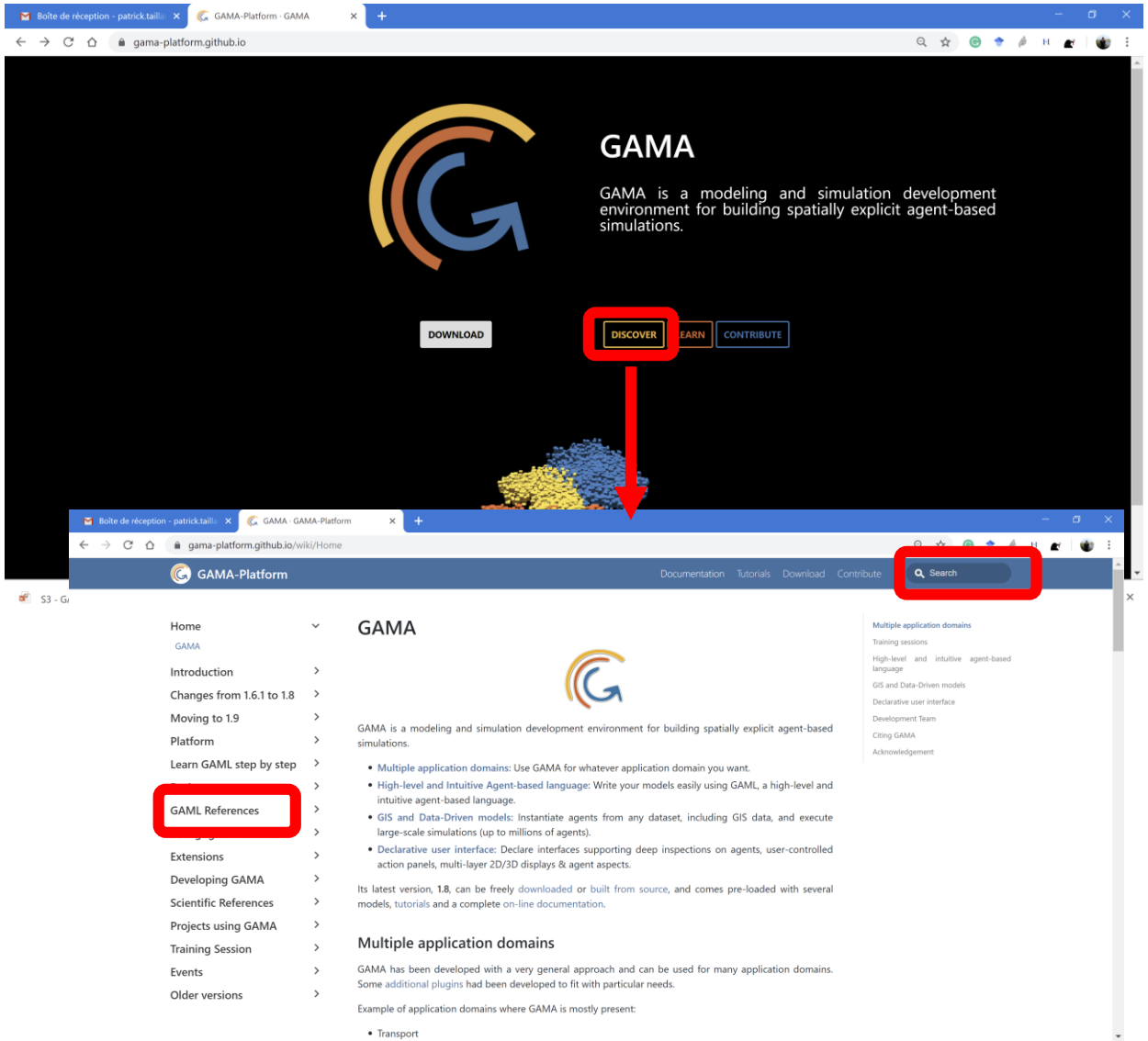


INSPECT INFORMATIONS BY AGENT BROWSER

- The species browser provides informations about all or a selection of agents of a species.
- The agent browser is available through the **Agents** menu or by right clicking on a by right_clicking on a display



GAMA: HOW TO GET DOCUMENTATION?

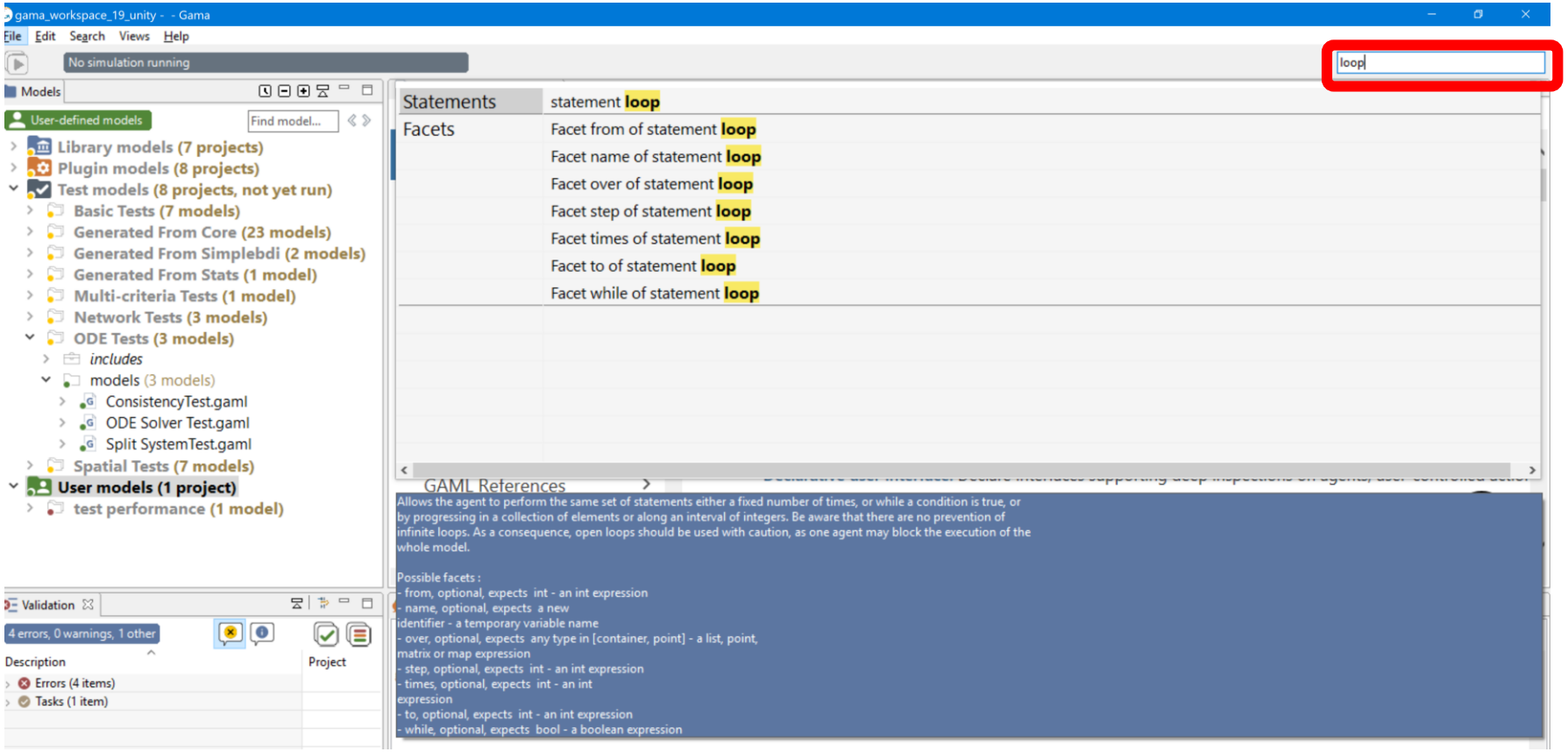


The Website of GAMA proposes a complete documentation of the platform and offers a search engine.

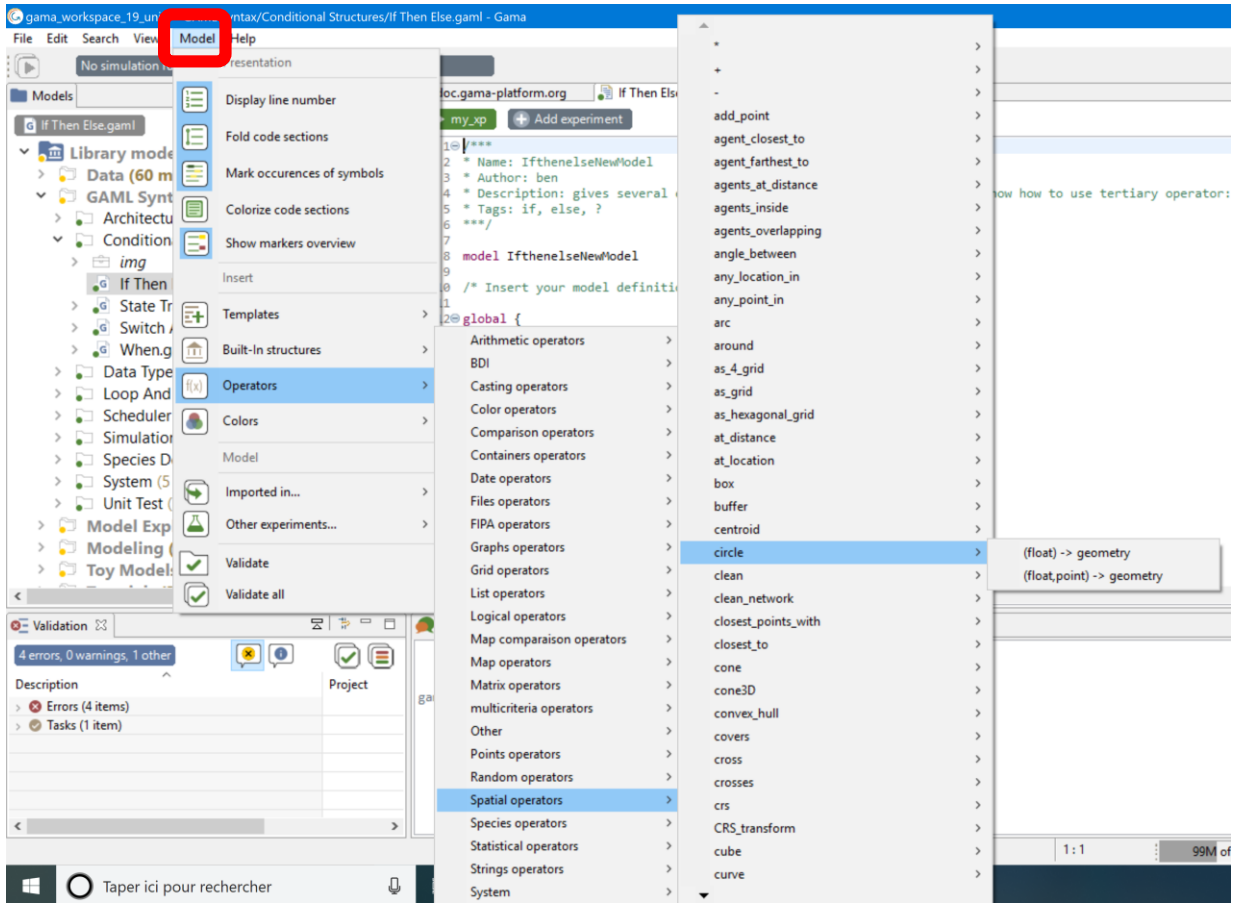
http://gama-platform.org

GAMA: HOW TO GET DOCUMENTATION?

A search engine is also offered by GAMA



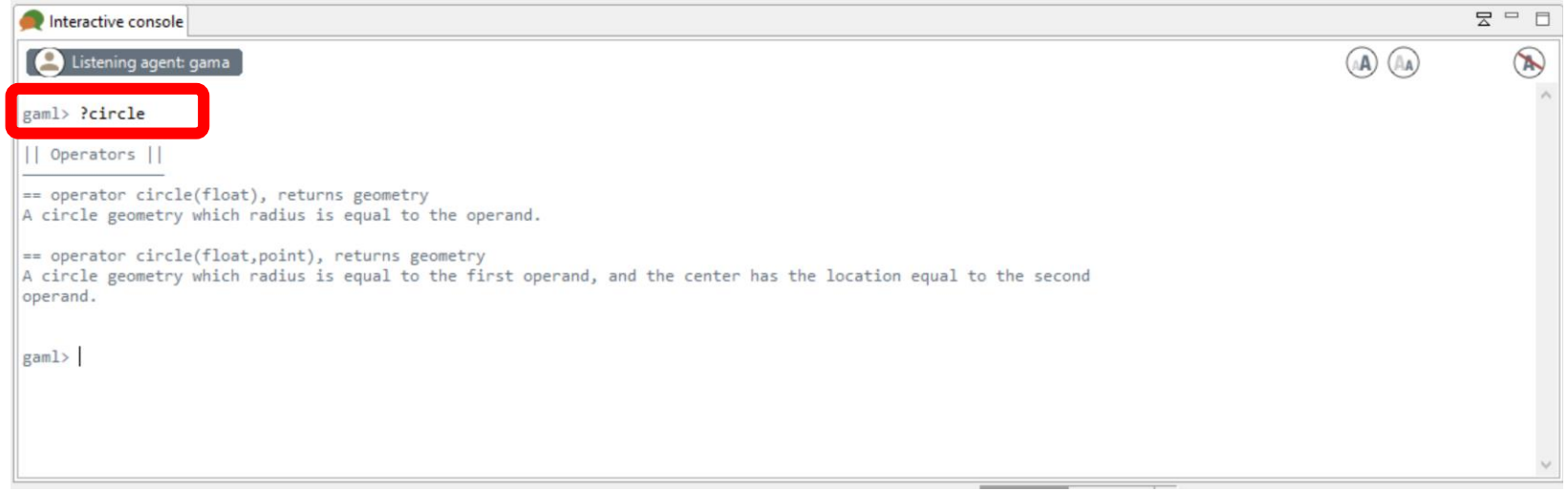
GAMA: HOW TO GET DOCUMENTATION?



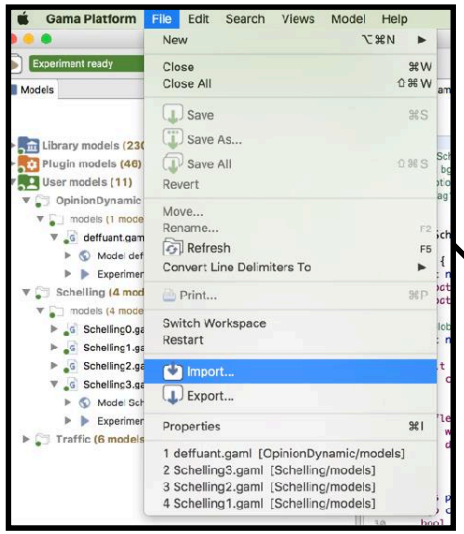
In modeling perspective, a list of all operators and statements is available.

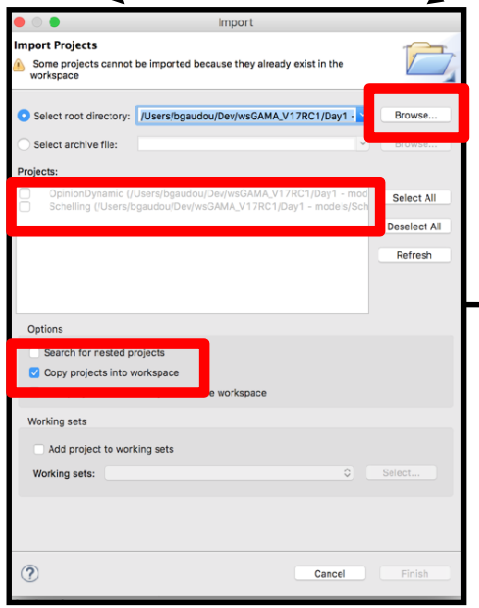
GAMA: HOW TO GET DOCUMENTATION?

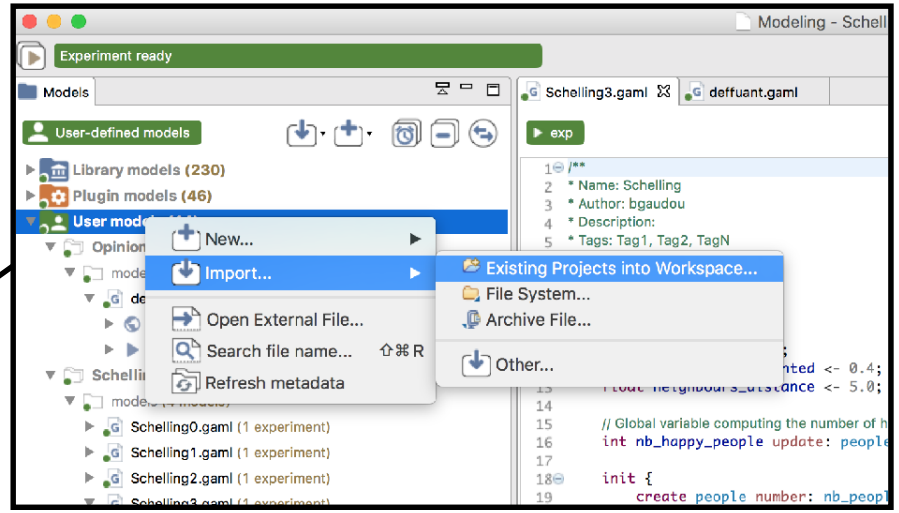
The interactive console enables to interact with a simulation, but also to ask questions to GAMA about an keyword. Just use « ? » before the keyword to have all the documentation about this keyword.



IMPORT EXISTING PROJECTS INTO THE WORKSPACE







Imported projects are now in the User models