

## Assignment: Sensitivity Analysis

The “Ants” model in GAMAs model library is another classic model. It is an example of an agent-based model that mimics strategies of living organisms to find heuristic solutions to computational problems. In this example, ants demonstrate how the shortest path problem can be solved with ‘swarm intelligence’.

In this assignment you will conduct sensitivity analysis with the Ants model. Remember: with sensitivity analysis you can assess, how much a change in a certain parameter value impacts the model outcome. Or with other words: how ‘sensitive’ a model is to uncertain parameter values. If an uncertain parameter value is changed only slightly within its range of possible values and this triggers large differences in the model outcomes, then it is said that the model is sensitive to changes of the tested parameter.

Sometimes, a model is sensitive if a parameter is changed in a certain range (let’s say small values), but the model becomes robust against parameter change for other parameter ranges (let’s say medium and large values of the parameter). This situation is actually quite common in all complex systems. To fully understand a model’s sensitivity it is therefore necessary to conduct a systematic sensitivity analysis.

GAMA supports systematic sensitivity analysis by offering a batch mode for the execution of experiments.

### Your task

Your task is to conduct a sensitivity analysis in order to assess, how sensitive the Ant model is to changes in the parameter *evaporation*. The number of cycles until all food is collected shall be the model result against to test. As the model has stochastic outcomes, you’ll need to repeat each experiment multiple times to find out the correct value distribution.

The expected result of this assignment is a chart in which you plot the tested values of the evaporation parameter (x-axis) against the mean, minimum and maximum number of cycles until the ants have collected all food (y-axis) for each set of simulations that were repeated for the same parameter value (in GAMA referred to as: *run*).

### Instructions

1. Download the .zip file “Assignment 4 Ants (Simple)” from Moodle

This .zip file contains the Ants (Simple) model, which was part of the GAMA library in previous versions. Unzip and import the model into your workspace.

## 2. Set up a Sensitivity Analysis experiment with GAMA

The Ants (Simple).gaml model offers 4 different experiments. Execute the “> Simple” experiment to see, how the model works. For a systematic analysis you can make use of the “repeated” experiment and modify it to meet the requirements of this assignment:

- Let's assume that the range of potential values for evaporation lie between 0.5 and 5.0.
- set an adequate repetition rate (min. 10 repetitions per simulation)
- modify the stop condition (i.e. no food left)
- Finally, you need to record the number of time steps (in GAMA: *cycles*) that the ants needed to collect all food for each of the simulations in a chart. It is up to you whether you save the data to a .csv and create the chart with Excel, or whether you use GAMA to plot the chart.

Finally, my tip: to shorten the overall runtime of the model, you may want to increase the amount of ants.

### Submit

1. A report on the model's sensitivity with respect to the evaporation parameter. In the report
  - a. document the main steps of your workflow,
  - b. present the outcome of the model experiment verbally,
  - c. provide your resulting chart, and
  - d. interpret its meaning: does the model react linearly to parameter change or is it a non-linear relationship? What do your results tell you about choosing an adequate value for the evaporation parameter? Do your biology colleagues have to invest a lot of time and money to get the precise parameter value right?
2. The GAMA model as part of the zipped “UNIGIS models” project.