VU VRIJE UNIVERSITEIT AMSTERDAM

Assignment 2
Agent-based Competition Modelling

Project Collective intelligence

Problem description

In this assignment, you will model agents that simulate competitive behaviours observed in nature. Often, this type of modelling is done using mathematical techniques such as ordinary differential equations (ODE) or more complicated ones. One of the most used examples, is a well-know Lotka–Volterra model, where the population is divided into two groups: Predator (e.g. Foxes) and Prey (e.g. Rabbits). This model captures the evolution of population sizes while highlighting the nature of the population dynamics. However, despite the fact that such a model is relatively simple to solve and study, it is unable to capture important details of predator-prey interactions observed in nature such as: individual differences (e.g. behaviours) that are present across the agents, the effect of the spatial distribution and of the topological or metric interactions between agents. Therefore, in this assignment we want you to explore an agent-based modelling approach to this problem.

Assignment Description

The time given for this assignment is 2 weeks, where by the end of it you also must hand-in a report. The exact design of the assignment is free to your choice. As a guideline, find below a list of bare minimum aspects to be modeled, and few ideas to extend the project further (bonus points):

1. An empty environment based on a Lotka-Volterra model: You start with a population of foxes (F) and rabbits (B). A fox reproduces (asexually) only if it encounters a rabbit and eats it (i.e. remove the rabbit from the simulation). On the other hand, a rabbit has a certain probability of spontaneous asexual reproduction and dies only if eaten by a fox. Foxes have a certain probability of spontaneous death, therefore they have to eat the rabbits to survive. (**This item is an essential minimum aspect to be modelled**)

2. Plots that show the changes in the population overtime (**This item is an essential minimum aspect to be modelled**).

3. Introduce an energy concept to the population of foxes - overtime the energy of the foxes decreases. They can replenish their energy by eating the rabbits. (**This item is an essential minimum aspect to be modelled**)

4. A comparative study between an energy-free scenario and the energy scenario. Experiment with the parameters of the simulation and see what influence they have. (**This item is an essential component**)

5. Introduce the energy concept to the population of rabbits - overtime the energy of the rabbits decreases. They can replenish their energy by eating grass. The grass can be regarded as a static agent itself. E.g. the grass grows overtime at (non-)random locations in the environment and can be consumed by rabbits once encountered. Grass regrows after a certain amount of time-steps and can be consumed again. (**Example of nice extra**)

6. Introduce flocking behaviour to one (or both) of the populations. (**Example of nice extra**)

7. Introduce sexual reproduction. E.g. reproduction (with some probability) happens when two agents (of opposite sex) of the same species meet. (**Example of nice extra**)

8. Introduce dynamic reproduction/death probabilities or speed of agents (e.g. proportional to the age of the agent). (**Example of nice extra**)

9. A number of locations in the environment that attract the rabbits (e.g. imagine: a place with surplus of food). Once the rabbits enter the environment they stay

there for some time (e.g. imagine: time to eat) and then leave. (**Example of nice extra**)

Presentation and evaluation

On Friday June 21rd, you will give a presentation of your intermediate progress. Be mindful that it is easier to present aspects that are completed, than work in progress. Our advice is to finish at least the no-energy scenario by Friday June 21th and to present it as a completed work. Of course, we encourage you to advance much beyond this on the first week, but beware on how you incorporate things that are not finished in your presentation. On Friday June 28th, you should give a final presentation in which you present the whole project. Both presentations should last max 15 min (excluding 5 minutes for questions). Note that if your presentation runs much over time, we unfortunately will have to cut it short and grade you on what we have seen up to that point. Please note the preferred structure below. This contains important elements around which your research should be organized and is reflected in the grading.

Introduction	Set the context of your research culminating in the research question. Your research question should be central in the presentation in that the other parts revolve around answering it
Methodology	Present how agents are modeled. How is their interaction implemented? Try to explain the main idea behind the code without showing the actual code (e.g. use finite state machines, formulas, or pseudo-code if everything else fails). Also introduce any metrics you use to analyse your results.
Results	Present the result, in the form of images and videos of the simulations, trajectories of the agents, and simple plots. It is important to show results here that help you answer your research question.
Conclusion	Conclude by answering your research question. Follow up by discussing issues with your research and finish with suggestions for future research.

Table 1: Presentation Sections

Feel free to explore other aspects of your experiments that are not covered by these sections but be aware that they should be extras and the evaluators are expecting you follow the guidelines (in terms of priorities) of the 4 sections above.

Deadlines

Deadlines assignment 2	
Progress Presentation	Friday 21-06-2024
Hand in slides on Canvas	Friday 21-06-2024
Final Presentation	Friday 28-06-2024
Hand in slides on Canvas	Friday 28-06-2024
Hand in report on Canvas	Tuesday 02-07-2024

Table 2: Deadlines Assignment 2