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 the well-known 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 cyclical nature of the population dynamics. However, as one can imagine, 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 modelled, and a few

ideas to extend the project further (bonus points):

Essential minimum aspects to be modelled:

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, and with some probability) 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. A fox has energy - over time the energy decreases. The fox dies when it runs out of energy. Foxes can replenish their energy by eating the rabbits, therefore they depend on them for survival.

2. Change the spatial behaviour of agents or introduce some environmental obstacles. For example, an environmental obstacle could be a lake or a river with a small passage that essentially creates two almost separated populations. You could also experiment by introducing flocking behaviour to one of the populations.

3. A comparative study between the two scenarios. Experiment with the parameters/objects of the simulation and see what influence they have. Try to utilise plots to convey your results.

Please keep in mind that the above list is just the bare bones of what you should implement in your simulation. We want you to go above and beyond this and implement your own ideas and ask your own research questions. However, if you feel lost please feel free to use the below list as an inspiration. Furthermore, there is extra material on Canvas ("Modules" > "Extra materials"), where you can gain more inspiration on what could be modelled further.

Examples of nice extras:

1. 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 over time at (non-)random locations in the environment and can be consumed

by rabbits once encountered. After being consumed, grass regrows after a certain amount of time-steps and can be consumed again.

2. Introduce sexual reproduction. E.g. reproduction (with some probability) happens when two agents of the same species (and possibly opposite sex) encounter each other.

3. Introduce dynamic reproduction/death probabilities or speed of agents (e.g. proportional to the age of the agent).

4. You may implement different foraging strategies explicitly, either individual or collective, and study the effect of spatial distributions of resources and of predator strategy on the different foraging strategies.

Presentation and Demo

Both the Presentation and the Demo will be graded. On Friday June 24th, 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 advise is to finish at least the no-energy scenario by Friday June 24th, 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 present results that are not final. On Friday July 1st, you should give a final presentation in which you present the whole project. Both presentations should last max 15 min (including showcasing the created simulation and excluding 5 minutes for questions), and the structure should be as follows:

Introduction	Briefly introduce the report: purpose of the simulation, type of analysis being done, questions that will be answered with the simulation.
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).
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 here how different parameters affect the collective behavior, especially parameters that have a connection on the idea of embodiment and physical interactions (between agents and between agents and the environment).
Conclusion	Conclude stating what you have learned. How do different choices concerning the embodiment affect the collective behavior/intelligence of the population?

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 24-06-2021 (during class)
Hand in slides on Canvas	Friday 24-06-2021 (during class)
Final Presentation	Friday 01-07-2021 (during class)
Hand in slides on Canvas	Friday 01-07-2021 (during class)
Hand in report on Canvas	Tuesday 05-07-2021

Table 2: Deadlines Assignment 2