Practical Work - Numerical simulation of Multi-Agent Systems

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1 Population dynamics with an agent model

1.1 "sheep-wolves" variant

1. **Q:** Using the available information in the "Interface" panel, describe the agents of the system and the rates that can be modified with the sliders.
   A: There are 2 different types of agents known as "a sheep" and "a wolf" and there are modifiable variables for *initial sheep/wolf count*, *sheep/wolf reproduce* and *sheep/wolf gain from the food.*

2. **Q:** Have a look at the code in the "code" panel. Look for the portions that describe the interactions between the agents (prey/predator ; prey/prey ; predator/predator). What interactions are there? Are those global or local interactions? (explain your answer)
   A: Agents have the abilities to move, eat(except the sheep) and reproduce. Preys(the sheep) does not eat any grass, therefore, they do not lose any energy for moving(to survive more, otherwise, there would not be any need for wolves to murder them) and predators lose energy while they are moving and they are reproducing from the food(the sheep) they eat. These interactions are local since they happen between the sheep and the wolves locally(i.e. a wolf tries to catch a sheep and then if caught, it eats that sheep; then it gains energy and then moves resulting with some energy loss and so on).

3. **Q:** Run several simulations and describe the observed dynamics. What is the relation between both populations?

   (a) **Q:** Over the simulations you ran, did you ever observe a stable system where both species co-exist (i.e. a limit cycle)? How about when you modify the parameters (with the sliders)?
   A: No, co-existence of both species did not occur. It is either the sheep or nothing surviving at the end which makes sense since the sheep can survive without wolves while the opposite is impossible.

   (b) Describe the influence of the parameters on the system dynamics. Are there some parameters that have a stronger influence?
   A: As far as I observed, the reproduction rate seems to have a bit stronger influence in the overall outcome.

   A:

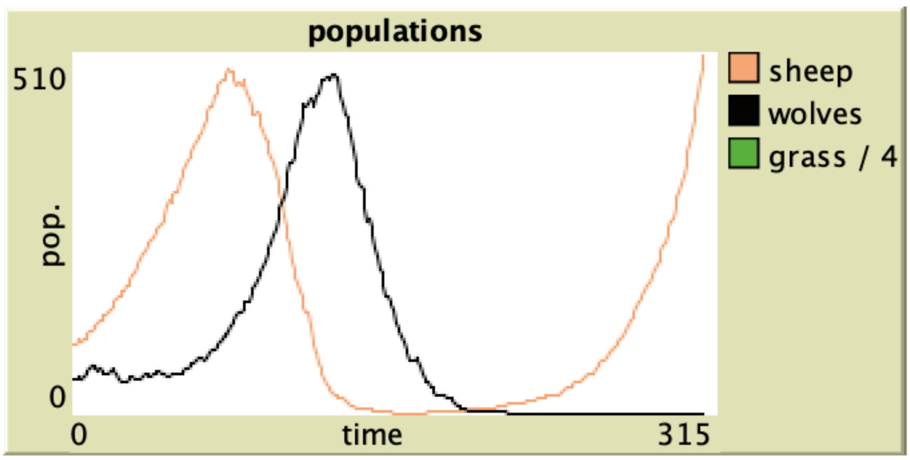


Figure 1: Sheep-wolf

4. **Q:** In this variant, in your opinion, what element of the model makes that the simulation is not very realistic? (explain your answer)
   A: There is no realistic relationship between the sheep and the grass. Also the case of diseases and the relief of surroundings(energy loss depends on this factor as well) are not taken into account.

1.2 "sheep-wolves-grass" variant

1. **Q:** Using the default parameters, run several simulations with this variant. What do you observe? (limit cycles, fixed points, ..., ?)
   A: Both species seem to be surviving with the default initial parameters. The number of the sheep and the number of the wolves approximates to the same number once in a while and afterwards, they start moving far away from each other to some extent from which they again start to converge. During this time, the amount of grass fluctuates as "a sin wave". The process repeats itself over and over again.

2. **Q:** Are the three populations dependant from one another? Describe the relations between all three population (you can use a graph)
   A:

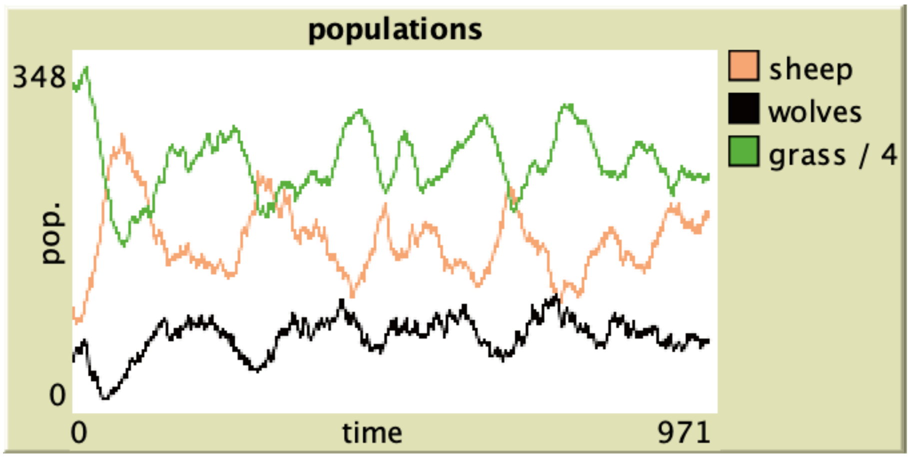
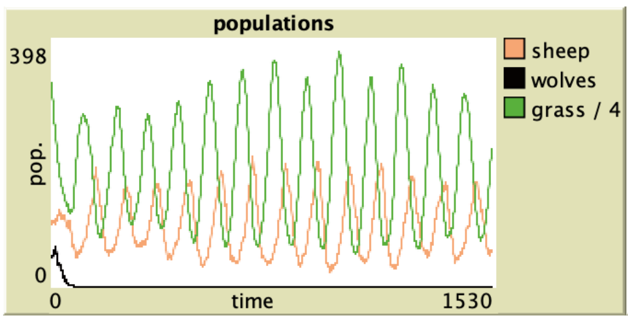
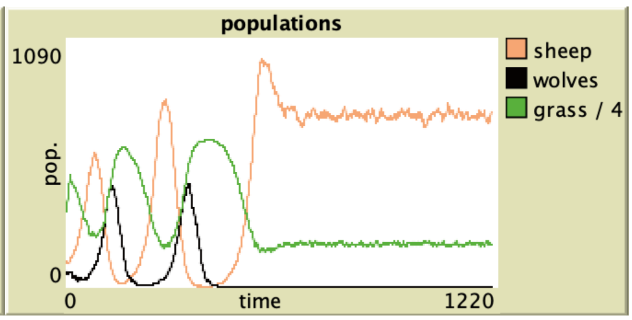


Figure 2: Sheep-wolf-grass

3. **Q:** Change some parameters (e.g. the weed growth rate) / the initial conditions (e.g. the initial number of predators) and run some more simulations. Is the system robust? (that is, even by changing some parameters, can you still observe a stable dynamics?)
   A: It seems like changing the initial number of preys/predators does not affect the system significantly(the average population of preys and predators stays at 150 and 75 respectively). However, changing the growth time of grass does affect to the outcome of system resulting with only the preys with no predators.



(a) No live predator



(b) No live predator

Figure 3: Grass growth time is lower than the default

1.3 Putting things in perspectives

1. **Q:** Why did I systematically told you to run several simulations in the MAS approach?
   A: Probably to observe the convergence of this approach that the almost same result(with slight

changes) is observed throughout different runs.

2. **Q:** Explain the notions of "global" and "local" approaches.
   A: Using a "meta-equations" to predict the outcome of the system is called a global approach since these equations do not describe the local interactions among the agents. Oppositely, dealing with local interactions to predict the outcome of a system is called a local approach.

3. **Q:** List at least 5 conceptual differences between ODE approaches and MAS approaches for the modelization of complex systems.
   A:

   (a) ODE approach is global unlike MAS approach which is local.

   (b) ODE approach requires solving differential equations unlike MAS approach.

   (c) ODE approach may fail depending on the measurement precision(slight changes may cause different outcomes).

   (d) MAS approach depends on "randomness" unlike ODE approach.

   (e) MAS approach has different programming structure than ODE approach.

2 Emergent or not?

1. **Q:** Run the model. What do you observe?
   A: By moving randomly, they(agents) start to form the piles of the same types of chips. Changing the number of agents, density and different types of chips changes the amount of time to form all the piles properly which is as expected.

2. **Q:** Is the behavior you observe emergent? (explain your answer)
   A: It is, to some extent. The piles are formed beautifully, however, they can move the whole piles as well(without mixing them with another piles with different colors). This is normal behaviour since one of the rules indicate that an agent has to put a chip near to another chip of the same type(color).