Projet 1 SMA

Killian Susini, Mathieu Ract

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1 How we got a stable system and implementation specificity

To get a stable system, it is important to understand the flow of energy. In our system, the grass is the sole source of energy. It is directly controlled by two variables: the grass growth speed and the amount of energy gained by the sheep when it eats it. It is however also indirectly controlled by the number and position of the sheep, since they are the one that can transform the grass in energy. In order to not have any more energy entering the system, when a wolf or sheep breed, they split their energy with their offspring (they need to have at least 2 energy to do that). Therefore no more energy is added to the system. Also, when the wolves eat a sheep, it gains slightly less energy than what a sheep would by eating a grass (10 instead of 12). This is interesting because in the natural world eating meat is much more nutritive than grass. At first, in order to keep the idea of flow of energy, we setup a system that made the wolf eat all the energy out of the sheep, but it was not easy to tune with a damping factor, and some wolves were very long lived. Putting a limit on energy accumulation could have worked too. Then the rate of birth was set to be much higher for the sheep than the wolves (0.15 each step against 0.05). The idea is that we want the wolves to not overwhelm the sheep through a growth explosion that would follow from a sheep growth explosion. However if there is enough sheep for enough time the wolves would overwhelm the sheep, and therefore it is necessary to have the time it takes for a grass patch to regrow be relatively high (40 steps) and the energy obtained by a sheep to be much lower than that (12) to create a upper limit on population of sheep, but high enough to create a high rate of growth when there is plenty of food. The result is that the population of sheep fluctuates a lot, especially because of the lack/abundance of grass, and this quick fluctuation fill the grid with food for the wolves, sustaining them. And just before they can overwhelm the sheep, the lack of food makes the population of sheep crash down, and the wolves are not enough to finish them off. Rinse and repeat. Note that without the action of the grass, to get a stable model is very hard. One of the hard part was to get the system to stabilize quickly. To do so, we needed to control the starting system. The starting population of wolves and sheep were set to be just enough to cover the place (for the interactions to start), but not to many too avoid a crash. Also, we added a control over the starting health of the sheep and wolves. But the biggest culprit for the instability at the beginning was due to the grass being too abundant. So we initialize it at a random step of its growth cycle. All of that was to increase the speed at which the system enters its cycling phase. This helped us set each variables quickly, by using a series of sliders to control the variables of the system. As can be seen on the graph below, the the grass "energy" (grass tile up times what the sheep gets from it) fluctuates about the same rate as the sheep. The wolves follow a dampened version of the sheep graph.

In our implementation, The sheep (or wolf) locate within their cell their source of food, and then let the model/environment deal with the consequences (if any) of this choice. Each step, the agent moves randomly, locate a source of food, ask the environment to eat that food, then ask for an offspring, and after that it lose its one energy and die if it is 0. This allow us to not give the agent the knowledge about their reproductive rates, energy gain, or to deal with the fact that their food may be already out. This makes those agent fully reactive, only checking if they can eat and do it if they can.