Excercise 1.
Implementing a first Application in RePast: A Rabbits Grass Simulation

Group №1: Célia Benquet - 271518 and Artur Jesslen - 270642

September 29, 2020

1 Implementation

1.1 Assumptions

1.1.1 Wildlife: the rabbits

The agents can wander around randomly in a discrete grid of modular size. As required, they can move in 4 directions (North, South, West and East) through one-step moves. At a given step of the simulation, the agents can either pick at random a direction (modular probability) or move in the previously designated direction. For the process of reproduction, we implemented an age to the agents. Hence, an agent is only able to reproduce after a given number of steps, independently of the energy level. When reproduction occurs, the rabbit can have a litter of one to a defined number of kittens. We added the maximal number of kittens in one litter as a slider variables to be studied. Once reproduction happened, the parent loses energy. It can loose at maximum, half of its energy, depending on the litter size (the bigger the litter, the more energy is lost during the process). Finally, if an agent is on a cell containing a given quantity of grass, it will eat the entire amount.

1.1.2 Ecosystem: the grass

Quantity of grass in one cell is upper-bounded. This bound is modular and was set to 20. Except during initialization, grass grows randomly on the entire grid at a modular growth rate. At each step, a given number of grass units is added to the ecosystem at a random location. This location can either be on an empty cell, then the count become 1 or on a non-empty cell, where the grass unit is added to the total quantity of grass in the cell i.e. the grass cell is growing.

1.2 Implementation Remarks

Grass is implemented as a quantity: if a new grass is added to a non-empty cell, it will just add up to the content. Rabbits are objects, they cannot be in the same cell as another rabbit. In the case where a new rabbit is not added successfully (e.g. all grid cells contain a rabbit), newborns are deleted. We added the 'Age' attribute to avoid newborns to give birth immediately after being born, and thus avoid exponential growth of the population when the initial amount of energy is higher than the birth threshold.

2 Results[1]

Settings used for each experiment are summarized in Table 1.

[1]In this section, we use different abbreviations for the different modulable parameters; BT = birth threshold, GGR = grass growth rate, MK = max kittens, GS = gridsize, NIG = #initial grass and NIR = #initial rabbit.

Experiments	BT	GGR	MK	GS	NIG	NIR
Experiment 1	750	**10**	6	20	100	**2**
Experiment 2	750	**5**	6	20	100	**20**
	750	**10**	6	20	100	**20**
Experiment 3	750	10	10	**50**	100	2
Experiment 4	750	10	**1**	20	100	2
	750	10	**15**	20	100	2
Experiment 5	**500**	10	6	20	100	2
	2000	10	6	20	100	2

Table 1: Settings for each experiment. Analysed parameters for each experiment are in bold.

2.1 Experiment 1-2: Grass growth rate versus Initial rabbit population

Here, we want to inspect the influence of the initial number of rabbits compared to the grass growth rate. In Experiment 1, we set a high grass growth rate compared to the initial number of rabbits. Experiment 2 is the opposite: low growth rate but high initial number of rabbits. In Experiment 1, because the growth rate is high, the model is able to support a high number of rabbits, without them running out of food. Hence, even with a low initial number of rabbits, they can reproduce and they don't die. This results in a stable system with a low grass quantity (but high update rate) and a large rabbit population. In Experiment 2, there isn't enough grass for the initial number of rabbits. They don't seem to gain enough energy to be able to reproduce. As a result, the population doesn't grow and either decreases until extinction for $GGR = 5$ or stabilizes with a small population and a small amount of grass for $GGR = 10$.

2.2 Experiment 3: Environment Size

In this experiment, we play with the size of the grid. We recognize a stable ecosystem with cyclic evolution. When there are many rabbits, the quantity of grass declines, which causes a famine and thus results in a rabbit population decline. In parallel, we hypothesized that having a small initial grass quantity and growth rate would lead to similar results than having a big grid. Indeed, we found similar shaped curves for both scenarii.

2.3 Experiment 4: Litter Size

Here, we observe the behavior of the simulation depending on the possible maximal size of a litter. Using a litter size of 1 then 15, we observe stable evolution in both cases. In the first scenario (1 kitten/reproduction), the grass quantity and number of rabbits evolve until reaching a stable value where the amount of grass created is exactly compensated by the energy expended by the rabbits. That can also be explained by the fact that there cannot be any abrupt demographic growth as each agent can only create one new agent. In the second case, we notice the same cyclic evolution as described in Section 2.2. The sudden demographic growth due to the birth of multiple new rabbits induces a strong reduction of the grass quantity that leads to the reduction of the agent population.

2.4 Experiment 5: Birth Threshold

Concerning the birth threshold, we tested 2 scenarii. The first, where $BT = 500$, illustrates how the ecosystem evolves when the BT is equal to the initial energy of the rabbits. In the second scenario, the birth threshold is much higher than the initial energy level ($BT = 2000$). In the first case, the population grows exponentially, until all the grass is consumed. The newly generated grass is not sufficient to keep the rabbits alive. In the second case, we observe a stabilisation of both the ecosystem and the wildlife as described in Experiment 2.3.