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

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1 Implementation

1.1 Assumptions

1.1.1 Assumptions for the Implementation of grass and of it's growth

There can be either 1 or 0 unit of grass per cell. At each simulation tick *GrassGrowthRate* (default 50) units of grass are added to empty cells **if possible**. This value is user defined and modifiable throughout the simulation.

1.1.2 Assumptions for the Implementation of the movement of Rabbits and of collisions

At each tick each alive rabbit tries to move to a random cell picked among the 4 cells adjacent to it's location. If it tries to move to a cell where another rabbit is present, **if the cell is empty it moves to it, if it is already occupied it doesn't move for this turn**. Regardless of whether it actually moved or not the rabbit loses 1 energy unit per tick.

1.1.3 Assumptions for the Implementation of feeding, energy and reproduction

Each rabbit has an energy value $e \in [0, 20]$. At each tick, if there exists a unit of grass on the cell it's on the rabbit "eats" it, it's energy increases by a user-set value. At each tick if a rabbit has an energy value $e \geq$ *BirthThreshold* it gives birth.

1.1.4 Assumptions for the Implementation of birth and death

When giving birth, **the parent rabbit gives a random proportion of it's energy to it's child**, meaning it losses some random amount of it's energy. The child inherits the exact amount of energy the parent lost when giving birth and appears on a random empty cell on the grid (the cell can have grass but no rabbit). The repartition of energy between parent and child is the following : $e_{parent} + e_{child} = e_{parent\ before\ birth}$. At each tick, after movement, feeding, and reproduction rabbits whose energy is ≤ 0, die: they are removed from the simulation.

1.1.5 Assumptions for the initialization of the sim

The model is initialized with a user-set number of grass cells and rabbits. Initial rabbits are given a random amount of energy $e \in [0, 20]$.

1.2 Implementation Remarks

In our model implementation energy is stored as a *double* value. An alternative solution could be the storage of a separate list of every free cell but such an implementation would be quite memory-intensive for large size simulations.

2 Results

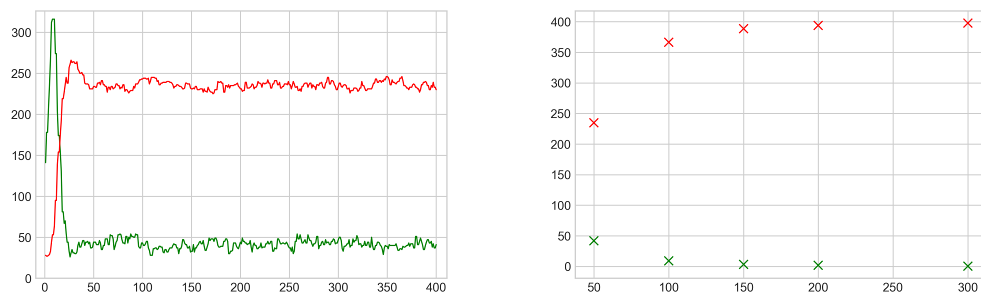

Figure 1: **Right :** Lineplots of the rabbits (in red) and grass (in green) populations over the first 400 ticks of the reference simulation. **Left :** Evolution of rabbit (red) and grass (green) population equilibriums as the grass growth rate changes (each point pair here is a simulation).

2.1 Experiment 1 : reference run

2.1.1 Setting

Default run : this will be our reference run. We will study the evaluation the simulation properties around those reference parameters.

2.1.2 Observations

We observe that the default run (Figure 1, left) converges in around 100 ticks to a stable regime where the prey and predator populations (number of individuals) oscillate around equilibrium values. This is consistent with how typical solutions of Lokta-Volterra equations should behave.

2.2 Reaction of the simulation to variation in parameters

We will now describe the way the model behaves in reaction to various parameters. First, let's observe that since the populations converge towards an equilibrium, as long as the initial populations of grass is sufficiently high so that the rabbit population does not die off, the initial populations values only have an influence on the transient response of the system, not on the stable state it converges to.

The grass growth rate is highly correlated with a high rabbit-to-grass population ratio, but saturates for high values see (Figure 1, right). The grass energy behaves similarly (although it saturates for different reasons). The birth threshold of rabbits has an optimal value (around 15) for a maximum rabbit-to-grass population ratio, this ratio gets lower for higher and lower values.

Finally a higher grid-size correlates to a higher grass-to-rabbit population ratio as well (and perhaps more interestingly) to a lower oscillation frequency in the stable mode.