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

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September 28, 2020

1 Implementation

1.1 Assumptions

The present simulation models the evolution of a rabbit population on a white landscape where grass is randomly growing. The landscape consists of a 20x20 grid. The field will be initialized with number of rabbits given by the parameter *NumInitRabbits* that will be assigned an initial energy level specified by the parameter *InitEnergy*. All rabbits are displayed in blue.
Furthermore, all over the landscape grid grass is growing at random places. At each simulation step and for each field on the grid, the value of grass will be incremented by 1 at a probability specified by the parameter *GrassGrowthRate* (this parameter should be between 0 and 1). Grass is displayed in green and fields with higher units of grass are displayed in a darker green color.

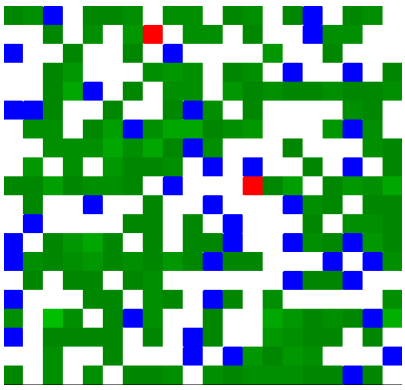

Figure 1: Visualization of the simulation

When a rabbit moves to a field with grass on it, it will gain the same number of energy units as there are units of grass on that field, meaning it will eat the complete amount of grass available at once. When a rabbit eats enough grass to reach a given energy level (specified by the parameter *BirthThreshold*), it will reproduce and one more rabbit will be added to the simulation space. Both the parent and the child rabbit will be set to have an energy level equal to *InitEnergy*.
Each of the rabbits moves at every time step and loses one unit of energy doing so. When the energy level of a rabbit falls to 5 or below, the rabbit will be displayed in red, and when the energy level falls below 0 the rabbit dies and it will be removed from the simulation.

In the simulation, the rabbits can only move in 4 directions that are north, east, south and west. Each rabbit will preserve its moving direction with a probability of 70% cases and will choose a new direction otherwise (note that this parameter is fixed and cannot be changed before the simulation launch). Since

two different rabbits cannot move on the same field, they will adapt their direction to avoid collisions. If all 4 directions around a rabbit should be blocked by others, it will remain in place and move during the next simulation step.
The landscape is a torus, meaning that if a rabbit leaves the landscape on one side, it will reappear on the opposite side and preserve it's direction.
Finally, when the rabbit population is very small, a huge amount of grass may be growing on the map. For display reasons the grass value cannot exceed 255 units per field.

2 Results

2.1 Experiment 1

2.1.1 Setting

Parameter	Value
Birth Threshold	30
Grass Growth Rate	0.1
Grid Size	20
Init Energy	19
Num Init Rabbits	10
Num Init Grass	10

Table 1: Default parameters.

2.1.2 Observations

The system behaves as a stable system, converging from the initial state to its equilibrium. The grass starts to spread quickly, and the rabbit population follows this trend with a time delay. Both curves then undergo a oscillation with decreasing amplitude, exchanging energy with each other and then gradually stabilise. The system behaves like a dampened oscillator.

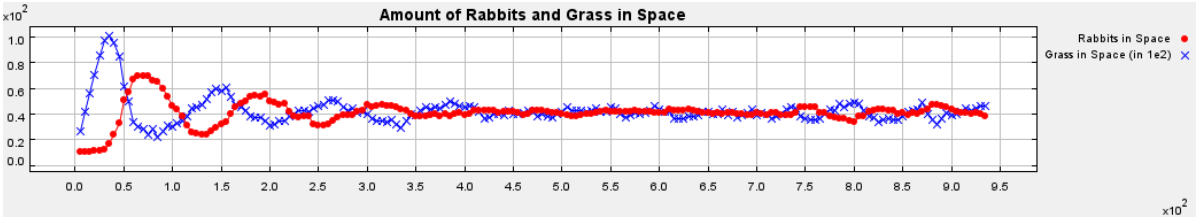

Figure 2: Baseline

2.2 Experiment 2

2.2.1 Setting

We lower the BirthThreshold to 20, which is really close to initial rabbit energy (19).

2.2.2 Observations

The rabbit population can reproduce very quickly, but also reduces quickly because of the shortage of food. After some oscillations, the rabbit population is so big, it consumes all the resources at once and extinguishes. Vegetation is then left alone and can thrive. Will humanity follow the same route ?

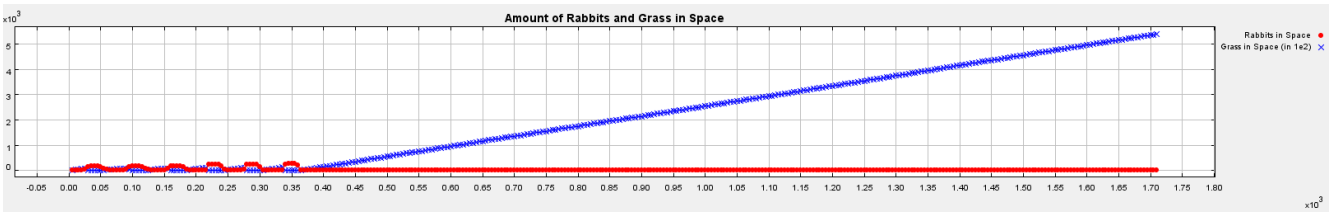

Figure 3: `BirthTreshold`= 20

2.3 Experiment 3

2.3.1 Setting

We lower the GrassGrowthRate to 0.025. BirthThreshold is back to it's default setting.

2.3.2 Observations

The population managed to survive a small amount of time and then suffers from the lack of ressources. It seems that the rabbit population can reestablish faster than the grass ressources, which leads to an amplified lack of ressources at the end of each oscillation. After the rabbits have died out, and the grass thrives.

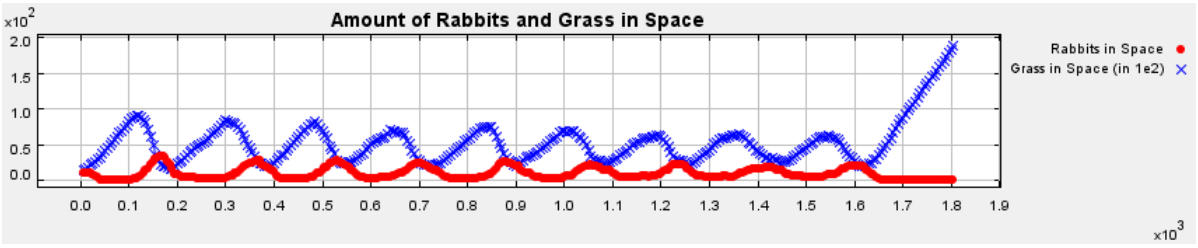

Figure 4: `GrassGrowthRate`= 0.025