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

Group №:22 Thomas Juel Andersen, Jeremia Oberle

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1 Implementation

1.1 Assumptions

There are several assumptions to be made about the world model. Grass will spawn continuously throughout the simulation at random fields in the world grid. The grass will disappear when eaten by a rabbit. Eating a field of grass requires that the rabbit is standing in the same field where the grass has spawned. Whenever a rabbit eats grass its energy level grows. When the energy level grows sufficiently high, the rabbit will "reproduce", i.e., double. The life span of a rabbit depends on his energy. When a rabbit is born, it has an initial energy level. Eating will keep it alive but moving to a new field will make it loose energy. If the energy reaches 0 the rabbit dies. Rabbits will be isolated, in the sense that they are unable to communicate. We make no difference between two fields of grass, meaning that if a field has already grass in it, no new grass can be spawn. Rabbits always earn the same amount of energy when they eat grass.

1.2 Implementation Remarks

The world is made up by a discrete grid of fields. Should a rabbit move outside the world it will simply be transported to the other side of the map. Rabbit movement is confined to four basic directions; NORTH, EAST, SOUTH, WEST. Overlapping rabbits (multiple rabbits on the same field) is not allowed.

2 Results

For the conduction of the simulations there are settable parameters before simulation run. Each parameter and its effect on the simulation will be described here.

- **World size** determines the size of the grid. The parameter has an effect on the density of both the rabbits and the grass. Low density will be mean rabbits have to travel further to get grass.
- **Initial rabbits** is the amount of rabbits at the start of the simulation. It is expected that the amount of rabbits will converge towards a sustainable amount as dictated by the spawn rate and density of grass. That is, reproduction of rabbits will not be possible unless there is sufficient grass. Scarce amounts of grass will result in a reduction of rabbit population and vice versa.
- **Birth threshold** is a doubling of a rabbit. Reproduction when a rabbit has eaten enough grass to raise its energy level to a specific threshold. When the rabbit reproduces, the energy level of the "parent" rabbit is reduced by the initial energy that the new born rabbit gets.
- **Energy gain** is the amount of energy a rabbit gets by eating grass.
- **Energy loss** is the amount of energy a rabbit looses by moving on a new field.
- **Initial energy** is the amount of energy a rabbit has on his birth. It is also the amount of energy a rabbit looses when he reproduces.
- **Growth rate of grass** is the frequency of grass appearing on the world each interval. The amount of grass available determines how many rabbits can be supported.

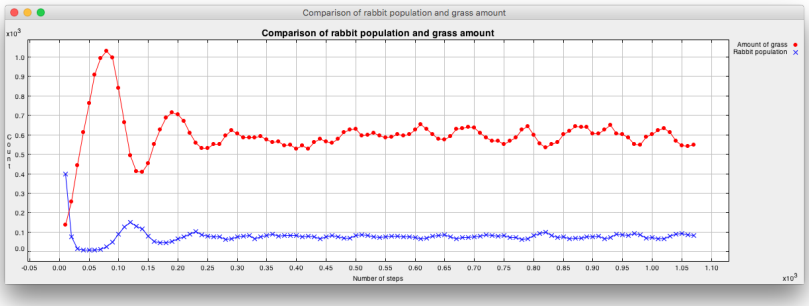
- **Initial grass** is the amount of grass spawn randomly in the world when the experiment starts.

2.1 Experiment 1

2.1.1 Setting

In the first experiment, we used the parameters as shown in 1a. We set a high amount of rabbits (400) in a grid of 800 fields. We also placed only 10 fields of grass with a growth rate of 30 per interval.

(a) Parameters for first experiment



(b) Results of the first experiment

Figure 1: Experiment 1

2.1.2 Observations

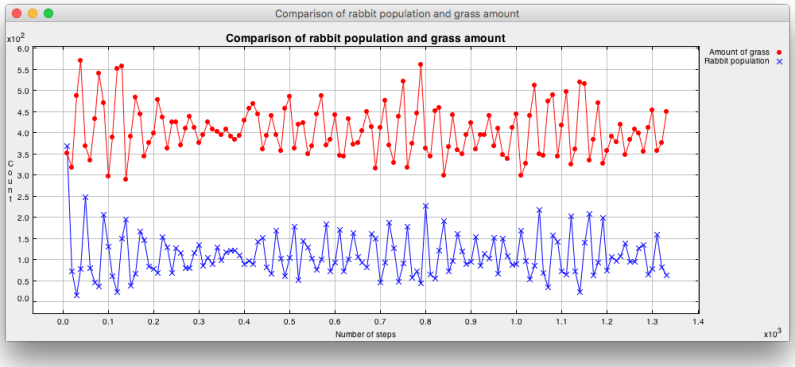
As the parameters indicated there would be scarce amounts of grass for the 400 rabbits. The result can be observed in 1b. The amount of rabbits (blue line) drops rapidly in the beginning as there is simply not enough grass to sustain the population. The rabbits almost extinct, however a few manage to survive and converge towards a sustainable amount. This tendency is observable when both, the amount of grass and the amount of rabbits approach a steady quantity (both lines approximate horizontal linearity).

2.2 Experiment 2

2.2.1 Setting

In the second experiment we flipped the settings in the sense that we now have 800 initial fields of grass on an 800 grid field. The initial amount of rabbits is 20 but we lowered the birth threshold to 30. The growth rate of the grass is still at 30. The settings can be seen in 2a.

(a) Parameters for second experiment



(b) Results of second experiment

Figure 2: Experiment 2

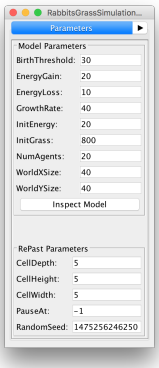
2.2.2 Observations

We observe that the number of rabbits drops in the beginning despite the high quantity of initial grass (not seen here as the counting skips the initial values and counts every 10th time interval onwards). The drop is partly due to the initial energy of the rabbits being very low. The initial low energy has another effect, which is that rabbits die more easily, as if they don't find grass in 4 time intervals; they will die. This effect is amplified due to the very low birth threshold. rabbits reproduce very easily. But the more they get, the less grass they have. This results in a lot of them dying. This explains why in this scenario we experience greater fluctuations in the amount of both rabbits and grass. The count of both parameters will however still converge towards the same horizontal linearity. The results can be seen in 2b.

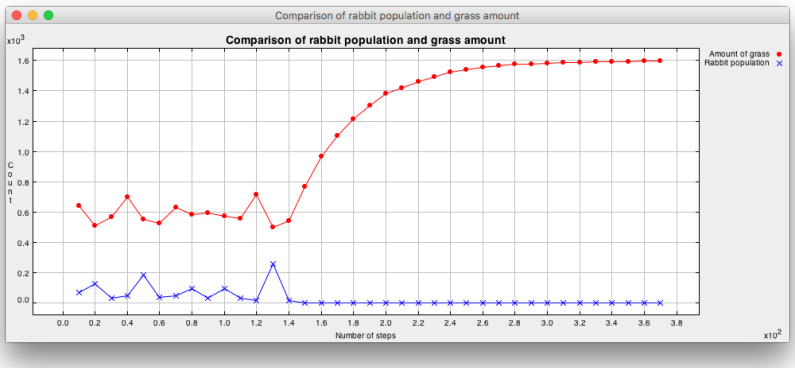
2.3 Experiment 3

2.3.1 Setting

The last experiment adjusts two parameters from experiment 2. The grass growth rate (up to 40) and the energy loss per step taken by the rabbits (up to 10). The settings can be seen in 3a.



(a) Parameters for third experiment



(b) Results of third experiment

Figure 3: Experiment 2

2.3.2 Observations

The last result are seen in 3b. Here we note that the energy loss per step is too big. The compensation in greater grass growth rate was insufficient in sustaining the population. The rabbits die after 150 steps.