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

Group №: 90 Kyle Grard, Yann Bolliger

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1 Implementation

1.1 Assumptions

- Our grass growth is bounded above linearly. We choose `grassGrowthRate` squares at each iteration tick and put grass on them. Regardless of whether there already is grass or not. In that manner we add *at most* `grassGrowthRate` new squares of grass at each tick.
- The energy of the grass in a cell is always equal to `grassEnergy`. This can be adjusted as a parameter.
- At birth, rabbits are placed at a random free cell. This can also be a cell with grass in it.
- Rabbits loose one energy point at each tick. This is the case even if the rabbit is surrounded on all sides by other rabbits and can't move therefore.
- Rabbits move completely randomly. For each tick, each rabbit chooses among the four possible directions and takes the first one that is not blocked by another rabbit. This means that rabbits can also go back and forth.
- The first generation of rabbits that appear in the space at the start of the simulation have all a default birth energy of 30 points.

1.2 Implementation Remarks

- We added another user-facing parameter: `grassEnergy`. All the adjustable parameters are bounded below by 0 but not above. Except for the grid size that has to be at least 1.
- Another edge case is when a rabbit cannot move because it is surrounded by other rabbits. In that case the rabbit will just stay where it is.

2 Results

2.1 Experiment 1

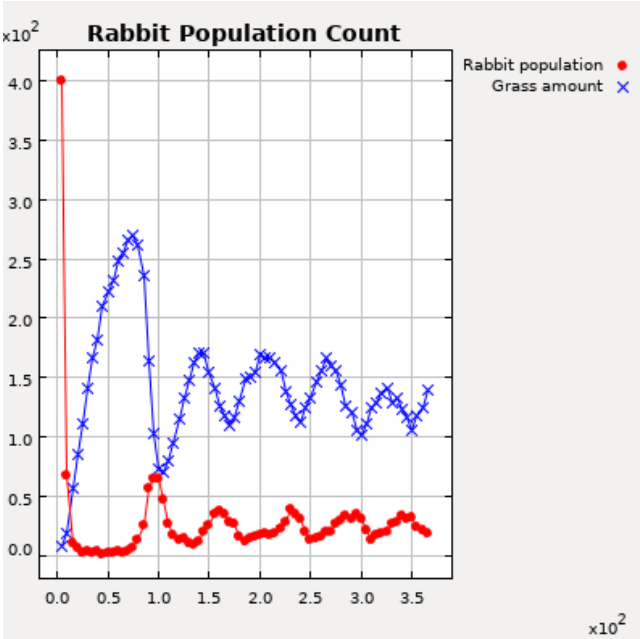
2.1.1 Setting

`birthThreshold`	10
`grassEnergy`	4
`grassGrowthRate`	9
`gridSize`	20 * 20
`initialNumberOfRabbits`	100

2.1.2 Observations

These parameters are enough to sustain rabbit life with a population oscillating between 10 and 40 rabbits. This seems reasonable since 36 units of grass energy (`grassEnergy * grassGrowthRate`) are generated at every tick and each rabbit uses one unit of energy at each step. Thus with this setting, the environment is not able to sustain more than 36 rabbits for long periods but is abundant in grass enough for some rabbits to survive.

We remark that neither the grass amount nor the rabbit populations are stable but instead they oscillate periodically like a sinusoid. Their periods seem to be very similar, however they are inversely synchronized (when the rabbit population goes up, the grass amount goes down; when the rabbit population goes up, the grass amount goes down).



2.2 Experiment 2

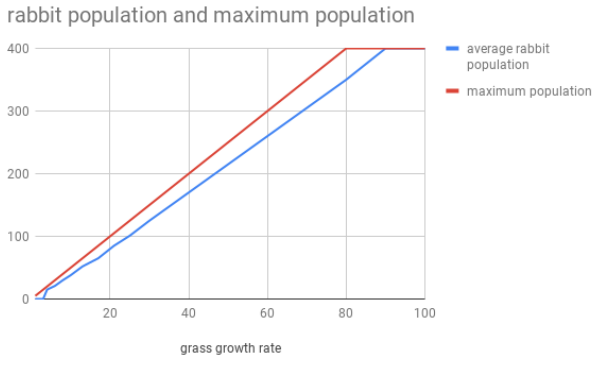
2.2.1 Setting

`birthThreshold`	40
`grassEnergy`	5
`grassGrowthRate`	x between 0 and 100
`gridSize`	20 * 20
`initialNumberOfRabbits`	100

2.2.2 Observations

As seen in the graph to the right, the population of rabbits increases linearly as a function of the `grassGrowthRate` until the maximum number of rabbits is reached (400 which is the number of places on the 20*20 grid).

The actual rabbit population follows closely the theoretical maximum of a sustainable population (`grassEnergy * grassGrowthRate`).



2.3 Experiment 3

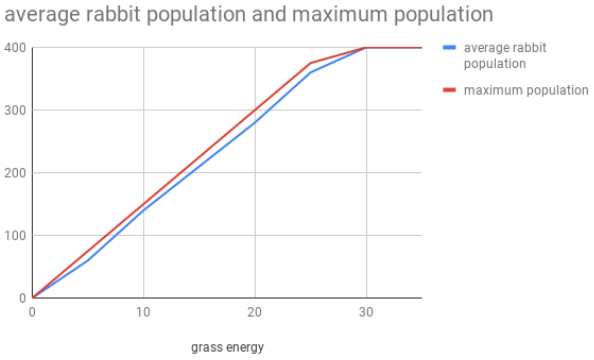
2.3.1 Setting

`birthThreshold`	40
`grassEnergy`	x between 0 and 30
`grassGrowthRate`	5
`gridSize`	20 * 20
`initialNumberOfRabbits`	100

2.3.2 Observations

As seen in the graph to the right and similarly to the previous experiment, the population of rabbits increases linearly as a function of the `grassEnergy` until the maximum number of rabbits is reached (400 which is the number of places on the 20*20 grid).

The actual rabbit population follows closely the theoretical maximum of a sustainable population (`grassEnergy * grassGrowthRate`).

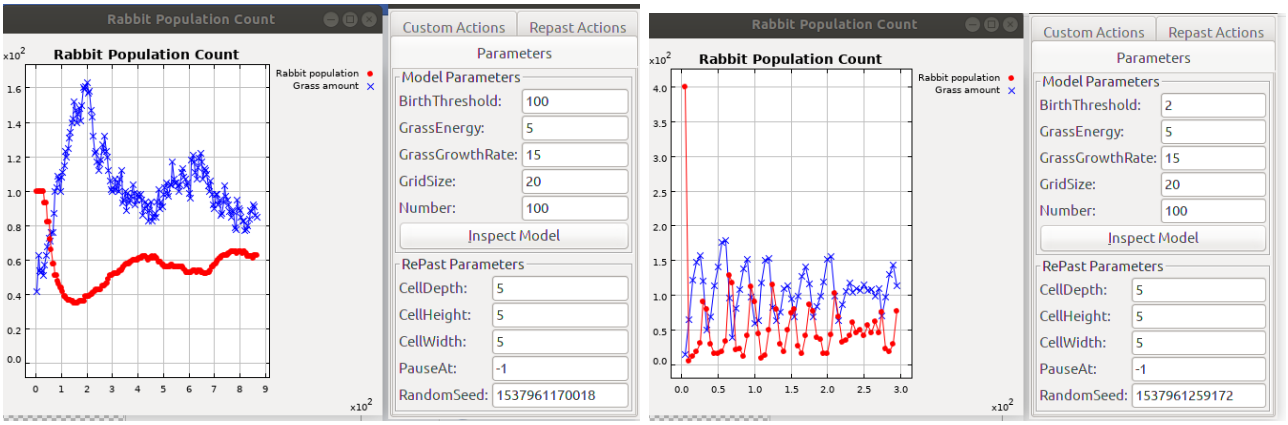


2.4 Experiment 4

2.4.1 Setting

`birthThreshold`	experiment a) 100; experiment b) 2
`grassEnergy`	5
`grassGrowthRate`	15
`gridSize`	20 * 20
`initialNumberOfRabbits`	100

2.4.2 Observations



As seen in the above graphs, the periods of the sinusoid-like rabbit population are much longer and their amplitudes smaller with a high `birthThreshold` compared to a low one. Indeed, with a `birthThreshold` of 100 we observe a period of around 200 steps and an amplitude of around 20 (population oscillates between 40 and 60 rabbits). With a `birthThreshold` of 2 , the period is only around 25 steps and the amplitude is above 90 (population oscillates between 10 and 100 rabbits).