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

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1 Implementation

1.1 Assumptions

- An infinite amount of grass can be stored in each cell, and a rabbit can eat as much grass as is available in a cell at a time.
- A rabbit loses half its energy when reproducing, so that its new energy level is below the energy threshold for reproducing.
- Every turn, a rabbit can change its direction of movement completely, and they lose 1 unit of energy for every step taken.
- Furthermore, we went with the idea that rabbits consume all the grass present in a given cell upon reaching it, leaving it empty.
- The lifespan is also variable in our implementation: this is added as an extra parameter, together with the energy factor which designates how much energy a rabbit gains when eating one unit of grass.

1.2 Implementation Remarks

- When moving, a rabbit checks whether another rabbit is present in the cell where it wants to move to, and if this is the case, the rabbit does not move this turn.
- Since the `reapDeadAgents()` function runs after the `step()` function, rabbits with 0 energy get deleted on the same iteration in which they run out, meaning there will never be a dead rabbit displayed on your visualization.

2 Results

We assume a grid size of 20x20 in all experiments.

2.1 Experiment 1 – Normal

2.1.1 Setting

Initial number of rabbits	10	Birth threshold	300
Initial amount of grass	10	Energy factor	1
Grass rate of growth	50	Initial rabbit energy	40

2.1.2 Observations

In this experiment, we see the number of rabbits slowly increase to around 50, after which it reaches an equilibrium state where it oscillates around this number. It takes around 600 ticks to reach this state. The amount of grass first increases sharply to almost 2900, after which it drops again to about 600 and then also reaches an equilibrium state where it oscillates around this number. This happens at the same time as when the number of rabbits reaches its equilibrium.

2.2 Experiment 2 – Loneliness

For that case figure we start with only 1 rabbit but increase the initial grass and the energy output of the grass but decrease the growth rate. The birth threshold is left untouched.

2.2.1 Setting

Initial number of rabbits	**1**	Birth threshold	300
Initial amount of grass	**50**	Energy factor	**10**
Grass rate of growth	**10**	Initial rabbit energy	40

2.2.2 Observations

This is a mixed case where the rabbit doesn't always make it. Sometimes the grass growth is unfavourable to it and makes it starve to death but other times he manages to eat enough early on to reproduce and reach a point where enough grass has grown to let the rabbits sustain themselves. Here we see the graphs of the 2 cases, one where the rabbit dies and the other where it thrives and reproduces successfully.

2.3 Experiment 3 – Drought

2.3.1 Setting

The grass rate of growth was reduced from 50 to 25 in this experiment. The other parameters are the same as in experiment 1.

Initial number of rabbits	10	Birth threshold	300
Initial amount of grass	10	Energy factor	1
Grass rate of growth	**25**	Initial rabbit energy	40

2.3.2 Observations

When comparing to experiment 1, we see that the reduced grass rate of growth leads to a lower mean number of rabbits in the stable oscillation phase of the simulation: it oscillates around about 25 rabbits instead of 50. The amount of grass seems to oscillate around 700 units of grass instead of 600.

2.4 Experiment 4 – Fertility

2.4.1 Setting

The birth threshold was reduced from 300 to 150 in this experiment. The other parameters are the same as in experiment 1.

Initial number of rabbits	10	Birth threshold	**150**
Initial amount of grass	10	Energy factor	1
Grass rate of growth	50	Initial rabbit energy	40

2.4.2 Observations

The birth threshold did not influence the amount of rabbits and grass in the equilibrium: it still oscillates around respectively 50 and 600, but the time until the equilibrium is reached is significantly shorter: it only takes around 200 ticks to reach the equilibrium, instead of around 600 in experiment 1.

2.5 Experiment 5 – Balanced

2.5.1 Setting

Initial number of rabbits	**50**	Birth threshold	300
Initial amount of grass	**600**	Energy factor	1
Grass rate of growth	50	Initial rabbit energy	40

2.5.2 Observations

This experiment was initialised at the values of the equilibrium state of experiment 1, and it is noteworthy that the transition between the initial state and the equilibrium state is less dramatic in this experiment than in experiment 1. The total amount of grass only reaches just below 1050 at its maximum instead of 2900 and the number of rabbits decreased to about 40 but also quickly goes back to the equilibrium state of experiment 1. It takes about 600 ticks to reach the equilibrium state, which is the same amount of time as in experiment 1.

2.6 Experiment 6 – Survival

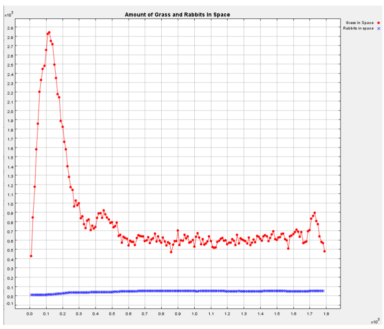
2.6.1 Setting

Here we are interested to see what minimal growth rate will allow rabbits to survive.

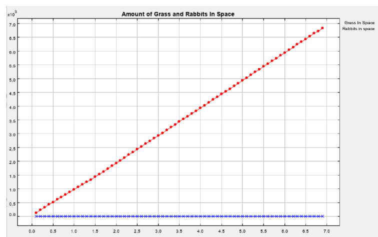
Initial number of rabbits	10	Birth threshold	300
Initial amount of grass	10	Energy factor	1
Grass rate of growth	**10**	Initial rabbit energy	40

2.6.2 Observations

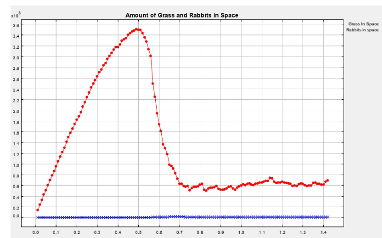
The lowest survival we managed to see was with a rate of 10, where less than half of our attempts had success. Most rabbits die at first with only one surviving with difficulty before eventually producing lots of babies suddenly and stabilising the simulation from there.



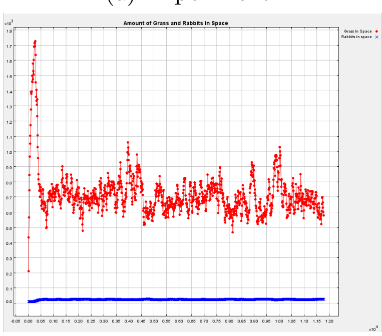
(a) Experiment 1



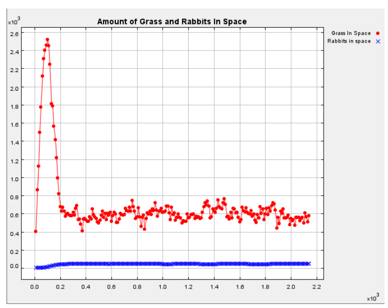
(b) Experiment 2-1



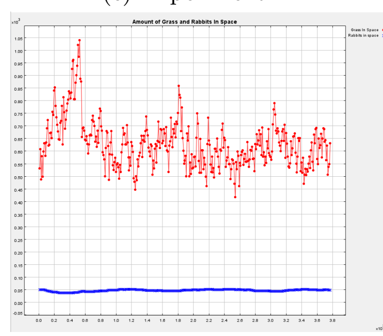
(c) Experiment 2-2



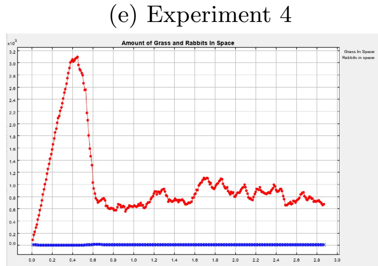
(d) Experiment 3



(e) Experiment 4



(f) Experiment 5



(g) Experiment 6

Figure 1: 2 Figures side by side