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

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1 Implementation

1.1 Assumptions

World model assumptions do not differ from what was requested from us in the simulation description however some specific decisions regarding implementation were made. Grass is growing randomly at whole world space and without limits to its location and at each time step additional unit of grass can be added to any space cell no matter if there already is grass in it or not. This way grass can give rabbits various amount of energy when eaten. When it comes to rabbit reproduction we assumed that each newly spawned rabbit starts it's life with a predefined value of initial energy for each rabbit equal to 35 while the default birth threshold was set to double the value equal to 70.

1.2 Implementation Remarks

Provided implementation is a complete baseline with only a set of basic limitations implemented. The value defining how much grass can be spawned in one time step is adjustable, however not constrained in upper, nor lower bound. Same goes to other adjustable parameters: number of rabbits, birth threshold and grid size. This lack of constrain can result in erroneous and unexplainable simulations if exploited. For example, one should avoid spawning more rabbits than the grid size or setting birth threshold to less then initial default value of rabbit's energy.

2 Results

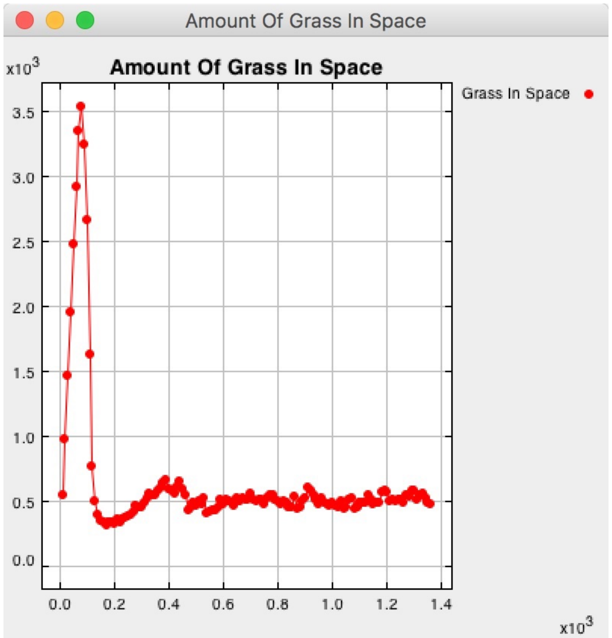
2.1 Experiment 1

Evolution of rabbit population

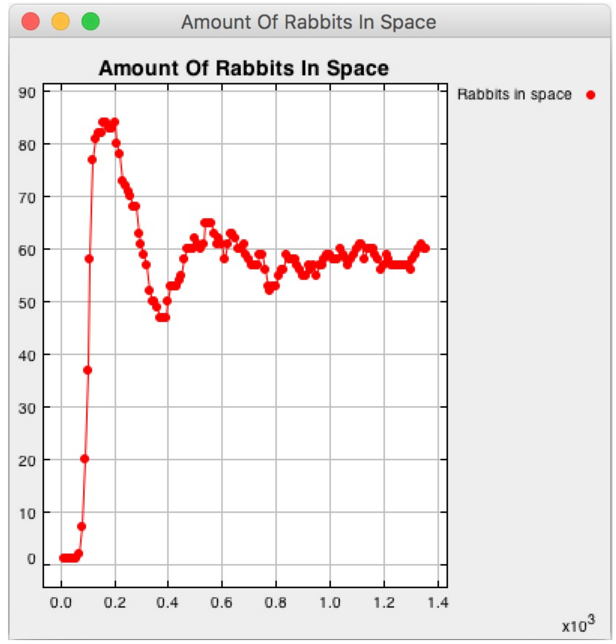
2.1.1 Setting

Grid Size: 20x20; Number of rabbits: 1; Birth Threshold: 70; Grass growth: 50

2.1.2 Observations



(a) Grass in space over time



(b) Rabbits in space over time

Figure 1: Distribution of grass and rabbits in space over time

Looking at the figures above, one can find confirmation of intuitive results of the simulation. Having spawned only one rabbit and growing 50 units of grass at each time step, firstly we can observe explosion of grass in space, since one rabbit is unable to eat all of it, just to witness similar expansion of rabbits population due to massive grass resources available. At its peak, rabbits population reaches over 80 rabbits, unfortunately the grass reserves are being depleted rapidly and with a growth of 50 units of grass at each time step such population is unsustainable. However after longer simulation period rabbits population seems to find point of relative stability at 57 rabbits with amount of rabbits varying $\pm$ 3, with stable amount of grass in the space oscillating around 500 units.

2.2 Experiment 2

The equilibrium amount of rabbits in existence as a function of grass growth.

2.2.1 Setting

Grid Size: 20x20; Number of rabbits: 1; Birth Threshold: 70; Grass growth: 10-100 (with step equal to 10)

2.2.2 Observations

Grass growth	Equilibrium reached	Grass in space	Rabbits in space
10	No	700	0
20	Yes	600	21
30	Yes	600	33
40	Yes	600	45
50	Yes	500	57
60	Yes	500	72
70	Yes	400	89
80	Yes	400	110
90	Yes	400	135
100	Yes	350	185

Influence of grass growth parameter

In the table above Grass and Rabbits in space are either at the equilibrium or at the end of simulation. One can observe that intuitively amount of grass growing in space has a direct influence on rabbit population expansion, and its final size. Surprisingly enough, the total amount of grass in space decreases with the increase of grass growth parameter, however it is driven by higher amount of rabbits and the limits of available space. Rabbits are covering more available space and thus eating more grass, having an impact on its total amount. The population growth is driven by the amount of grass grown at each time step and the probability of rabbit randomly finding it.

2.3 Experiment 3

The equilibrium amount of rabbits in existence as a function of birth threshold.

2.3.1 Setting

Grid Size: 20x20; Number of rabbits: 1; Birth Threshold: 40-100 (with step equal to 10); Grass growth: 50

2.3.2 Observations

Birth threshold	Equilibrium reached	Grass in space	Rabbits in space
40	Yes	400	70
50	Yes	500	65
60	Yes	500	60
70	Yes	500	58
80	Yes	500	57
90	Yes	500	56
100	Yes	500	55

Influence of birth threshold parameter

Birth threshold parameter seems to have the biggest impact on rabbits population for two reasons. Firstly, the amount of grass to be eaten to grow a certain size of population becomes smaller. Secondly, the energy distribution among rabbits is more stable since the gap to bridge from initial energy level to reproduction level becomes smaller.

2.4 Experiment 4

The energy distribution among living rabbits in equilibrium for different grid sizes.

2.4.1 Setting

Number of rabbits: 1; Birth Threshold: 70; Grass rate adjusted to grid size according to the amount of tiles in the grid; World size 20x20 up to 300x300.

2.4.2 Observations

In equilibrium there are two observations to be made. Firstly, equilibria with higher grid sizes are more stable in energy distribution among the rabbits (and more stable in number of rabbits). This can be explained through the larger amount of rabbits in equilibrium in these grids and thus the compensated randomness of their actions. Secondly, for the larger grid sizes or the more stable energy distributions is to be noted that they approach a Gaussian form. This off course is very dependent on the specific choice of birth threshold, double the initial energy.

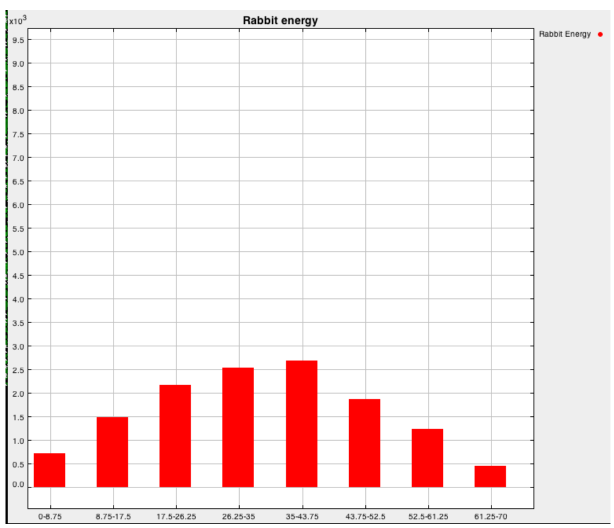


Figure 2: Distribution of energy among rabbits in equilibrium for large grid size (300x300)

Notice that the energy distribution for small grid sizes is not shown, since the wealth distribution is not stable.