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

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1 Implementation

This section aims to illustrate some necessary implementation details of our model. To save space, we include screenshots of our model in the appendix.

1.1 Assumptions

- World assumptions:
  1. At the beginning of a simulation tick, newly generated grass is randomly placed on the grid. For a specific cell, it can only be occupied by one grass. All grass have same level of energy.
  2. At the beginning of one simulation, rabbits are placed randomly on the grid. Two or more rabbits cannot stay in one cell. A rabbits will reproduce when its energy is higher than the maximum energy threshold while it dies when its energy is less than 1.
- Key behaviour assumptions:
  1. Rabbits cannot communicate with each other and can only move randomly to four directions.
  2. The newly born rabbits inherit energy from its parent: $E_{child} = E_{parent} - E_{max}$, where E denotes energy level of a rabbit and E_{max} denotes the maximum energy threshold.
  3. Since the rabbits are required to be blind, we set the *tryMove* method consumes energy, no matter whether the following movement is carried out successfully (target cell is free of rabbits) or not (target cell is occupied by other rabbits). However we only penalise once, i.e., the rollback of a failed try doesn't consume energy.

1.2 Implementation Remarks and Boundary Conditions

Users can adjust model parameters via provided sliders and we restrict all parameters to be type `int`. When the parameters are set up and the user clicked the start button, initial amount of grass and rabbits are spread among the whole space. Then at each simulation tick, new grass is spread based on given growth rate and rabbits start moving and possibly reproducing. Afterwards, rabbits that have energy smaller than 1 is reaped and new simulation tick starts.

At the beginning of a simulation tick, if the number of grass-free cells is smaller than growth rate, the grid will be added with grass to full while the remaining grass to be added will be omitted.

2 Results

Within this section, we provide some details about our experimental results over the system and corresponding analysis. Following table displays our model default setting and without indication, the default setting applies. Appendix 1 Figure 5 displays the homeostasis of amount of grass and rabbits. Figure 6 displays if the energy consumption per movement is higer than grass enery, the rabbits dead out.

Table 1: Default model setting

Energy Loss	Grass Energy	Growth Rate	Init. Grass	Init. Rabbit	Repro. Threshold	Area
1	5	15	100	150	15	20×20

2.1 Influences of initial amount of grass

In this experiment, we vary the amount of initial grass from 50 to 300 while resting parameters follow the default setting.

Figure 1 shows that regardless of the initial amount of grass, the final number of rabbits always fluctuates between 69 and 81. This is because the initial amount of grasses only effects whether the number of rabbits increases or decreases at the beginning. As simulation goes on, the total amount of newly grown grass becomes larger and larger, comparing to which the initial amount of grass is negligible, so the initial amount of grass won't influence the final number of rabbits.

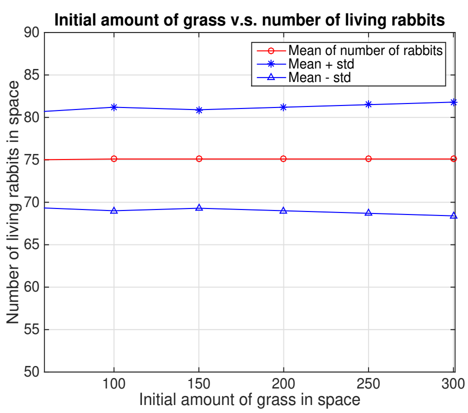


Figure 1: Impacts of initial amout of grass

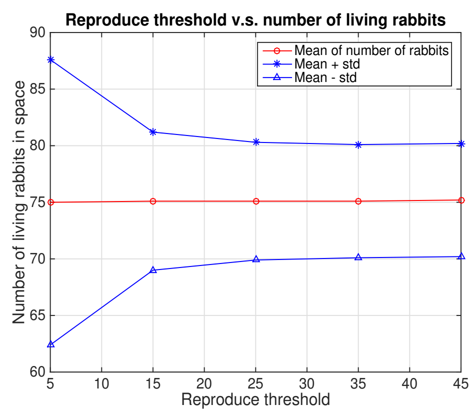


Figure 2: Impacts of reproduce threshold

2.2 Influences of reproduce threshold

In this experiment, the reproduction energy threshold of rabbits is adjusted from 5 to 45 while resting parameters follow the default setting.

Figure 2 shows that with the reproduction energy threshold increasing, the mean of the final number of rabbit is 75, remaining the same, but the variance decreased from 12.6 to 5. The reason is that the total amount of energy put in the space in every step is constant, and this amount of energy will be consumed by constant number of movements, limiting the final number of rabbits into a constant range. Higher reproduction energy threshold results in lower chance of reproduction, hence the variance of the number of rabbits is reduced.

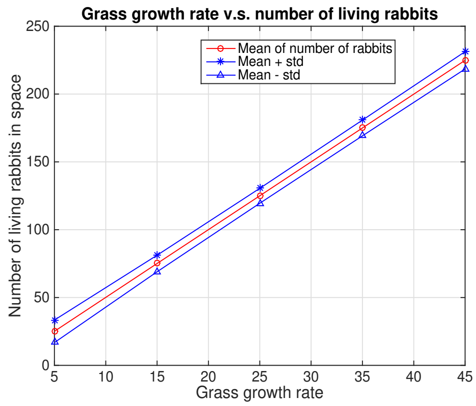


Figure 3: Impacts of grass growth rate

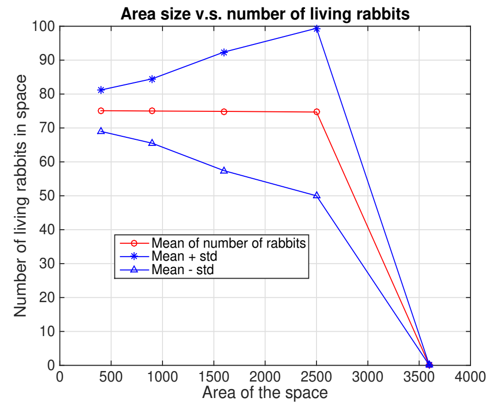


Figure 4: Impacts of space area

2.3 Influence of grass growth rate

In this experiment, the grass growth rate is adjusted from 15 to 45 while resting parameters follow the default setting.

Figure 3 shows that with increasing grass growth rate, the final number of rabbits is also increasing. This is because the total amount of energy put into space at each step is higher than previous ones, and this amount of energy will be consumed by rabbits when the number of rabbit becomes stable, so there will be more rabbits be accommodated in the space.

2.4 Grid area impacts

Within this experiment, the space has square shape and its area varies from $20 \times 20, 30 \times 30, 40 \times 40, 50 \times 50, 60 \times 60$. For resting parameters, default setting applies.

It can be observed from Figure 4 that the mean of final number of living rabbits remains roughly the same when the area size is smaller than 2500. However, when the size reaches 3500, all rabbits were dead. We believe that increasing the size could result in increasing the energy loss per movement since rabbits have to move further to eat grass. We also found that the variance of rabbits number increases along with the increase of space size.

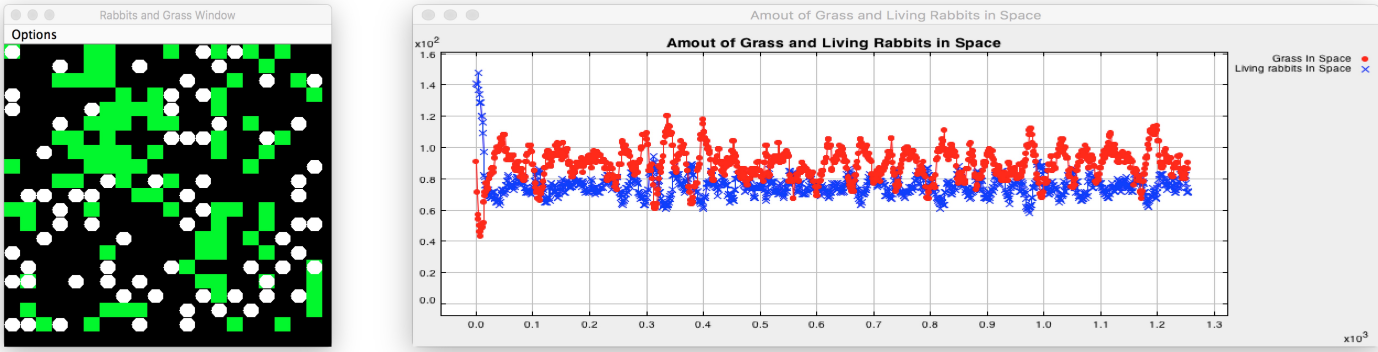
2.5 Impacts of energy gain per movements

Within this section, we define the energy gain factor $G = \frac{E_{grass}}{E_{loss}}$, which is the ratio between energy per grass and energy loss per movement for a rabbits. Intuitively, when $G = 1$, the net energy of a rabbit movement is 0. And when G is smaller than 1, all rabbits will die since the net energy of a movement is minus. Following table displays our experimental results, which meets our expectation:

Table 2: Influences of G over number of living rabbits

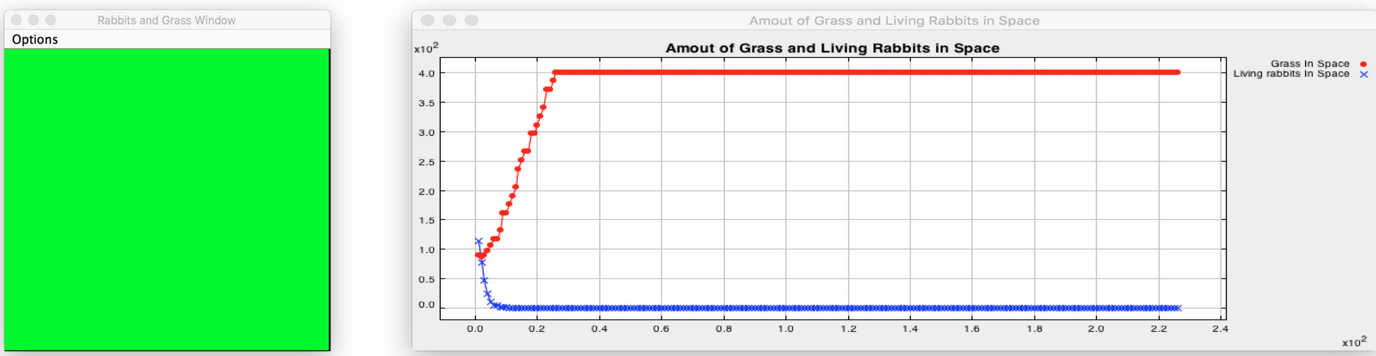
G	10.0	5.0	3.3	2.5	2.0	1.7	1.4	1.3	1.1	1
Alive/DeadOut	A	A	A	A	DO	DO	DO	DO	DO	DO

3 Appendix 1



(a) Rabbits and grass distribution (b) Amount varies of rabbits and grass along with increasing simulation ticks

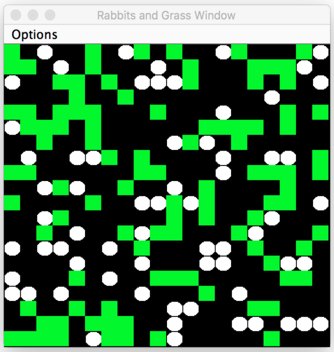
Figure 5: Distribution and amount variation of rabbits (white) and grass (green). Reaches stable oscillation (homeostasis) eventually.



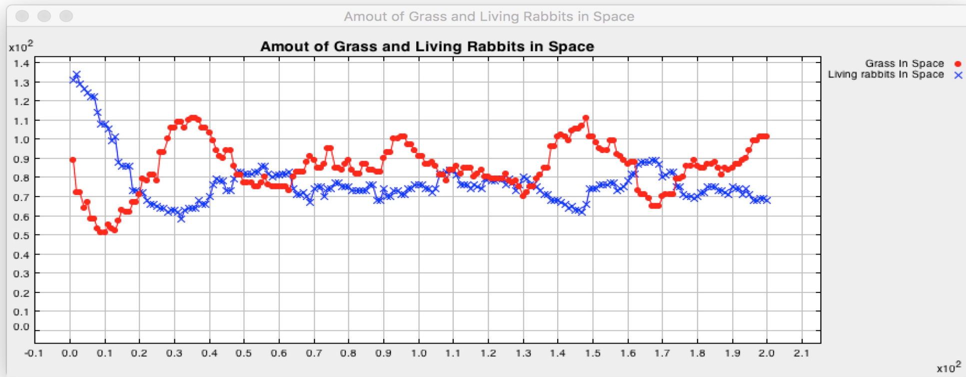
(a) Rabbits and grass distribution (b) Amount varies of rabbits and grass along with increasing simulation ticks

Figure 6: An unstable distribution. Energy consumption for a movement is larger than energy of one grass. All rabbits dead and all cells have grass.

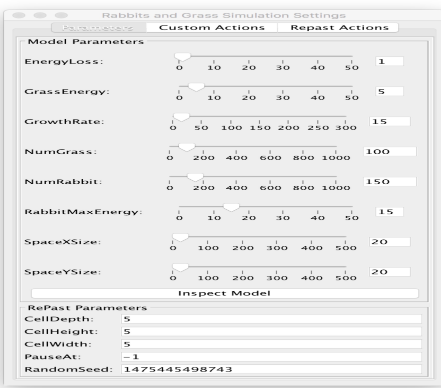
4 Appendix 2



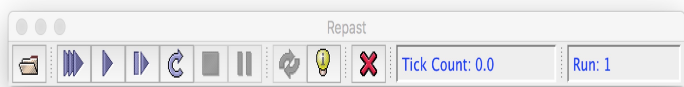
(a) Background-back, Rabbits-white, Grass-green



(b) Amount varies of rabbits and grass along with increasing simulation ticks



(c) Setting panel



(d) Control bar

Figure 7: An unstable distribution. Energy consumption for a movement is larger than energy of one grass. All rabbits dead and all cells have grass.