

Data Science

Ecosim Report

Rishi Urs and Rianna Wadhwani

Introduction:

Our simulation visualizes predator-prey dynamics in a self-contained 200 by 200 field. This field encapsulates a portion of a larger field of grass. The green pixels show the grass, the white pixels show the rabbits feeding on the field, and the red pixels show the foxes hunting the rabbits. In every generation, the rabbits move one step; we see the patches of the field nibbled by the rabbits depicted by the black pixels (bare soil). The foxes move three steps and feed on the rabbits they come across. When these animals don't feed for a certain number of generations (1 for rabbits, and 20 for foxes), they starve and die. When they can prey, they reproduce (3 kits and 2 cubs). Each bare cell has a 5% chance to regrow grass. The top bar of the animation provides the current generation number, along with the number of alive rabbits and foxes.

Model assumptions, for both rabbits and foxes:

Assumptions	Rabbits	Foxes	Reason
Initial numbers	200	25	Ensures prey are common enough to ensure foxes(hunters) find food in early generations. Predators start scarcer than prey to avoid over-predation.

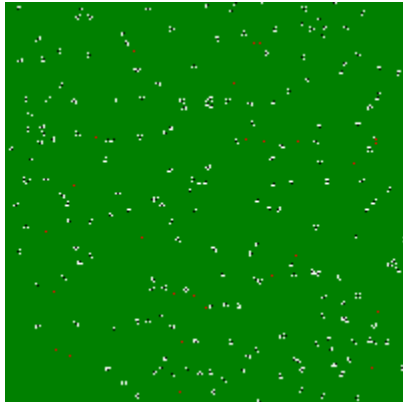
Max number of offspring	3 kits	2 cubs	“Breed like rabbits” however, is still bound to prevent explosive growth. Slower reproduction compared to rabbits allows for higher parental investment.
Starvation level	1 generation	20 generations	Rabbits are fragile; going one generation without grass is fatal. Allows foxes to roam and find prey patches on the larger grid.
Reproduction level	1	1	One grass patch is sufficient energy for the rabbit to breed once. One hunt is sufficient energy for the fox to breed once.
Extra moves every generation	0	3	Keeps rabbit movement moderate, hence clusters form for predators. Improved roaming radius improves hunting success for foxes.
Grass growth rate	0.05 per cell per generation	–	This allows the grass to regrow and provide more food for rabbits.

Tuning done:

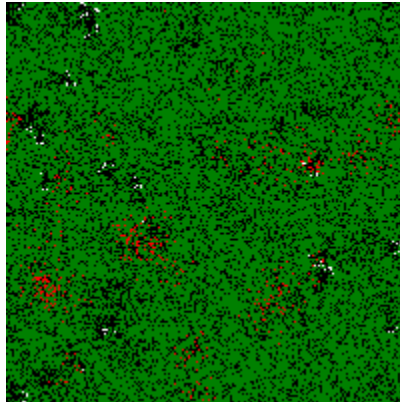
We tuned the initial count of the animals, starvation level, and max offspring level. We found that the foxes were initially dying. This was due to their lower initial count vs that of rabbits. The feed for the rabbits, being grass, was more readily available considering the 0.05 grass growth rate. However, the small population of foxes was unable to prey frequently. Setting the initial fox

count to 25 and changing their max offspring level allowed them to avoid becoming extinct and repopulate later. This could probably be because they “learn” survival and hunting skills, i.e., be able to hunt enough times.

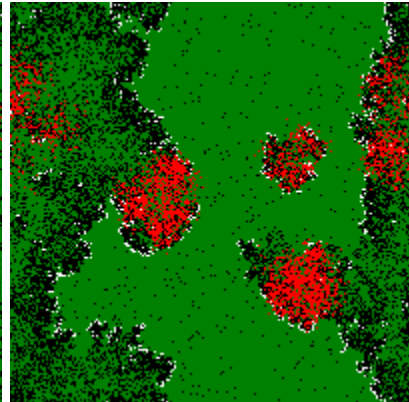
Landscape at various generation intervals:



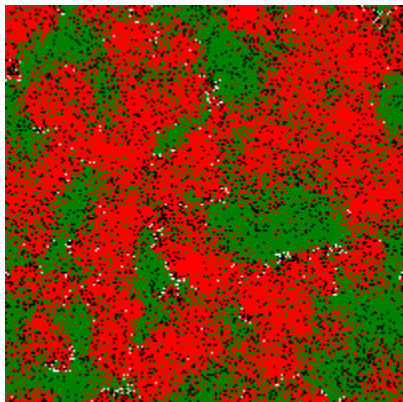
Generation 0



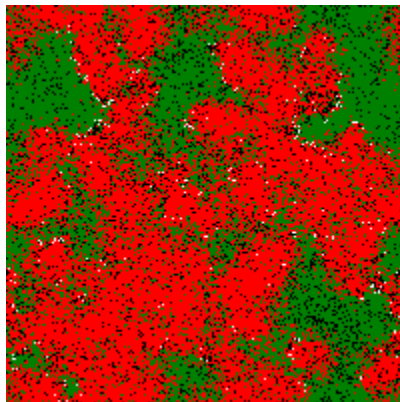
Generation 40



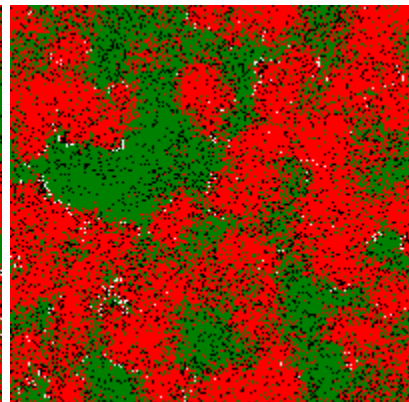
Generation 90



Generation 100



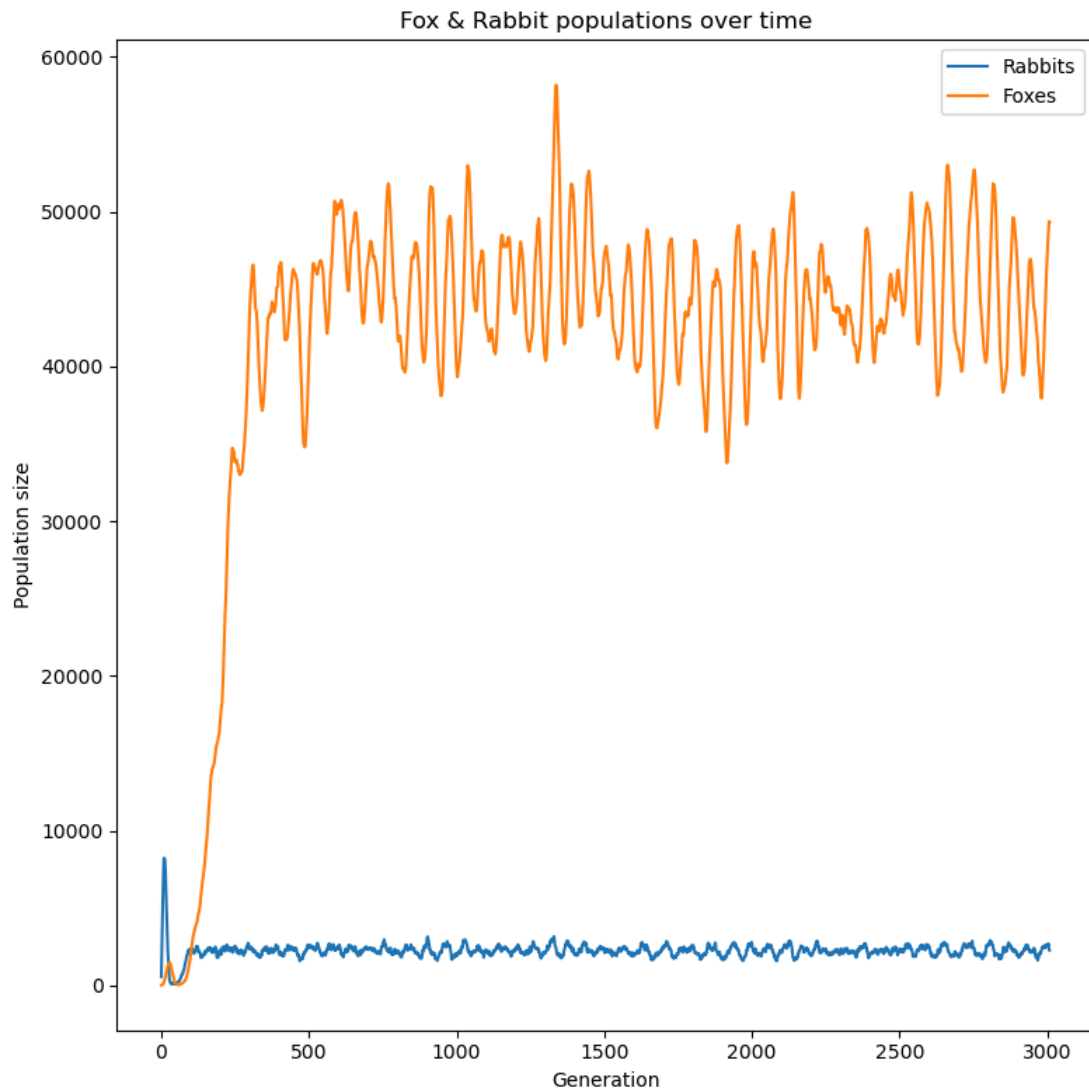
Generation 500



Generation 100

Generation	What is happening
At 0	The initial count of rabbits is higher than that of foxes
At around 40	<p>The rabbits feed on the abundant grass (they are herbivores)</p> <p>The foxes begin to starve and are about to become extinct.</p> <p>This stage indicates whether or not the foxes will survive in future generations</p>
At around 90	If some foxes can prey and hunt enough, their population slowly begins to dominate the field. This also leads to a reduction in the number of rabbits as the foxes' population increases
At around 500	This pattern reoccurs where small patches of rabbits survive, and foxes prey on them.
At around 750	Since the fox population is rapidly increasing, there are more foxes compared to rabbits, so their food is being depleted. This leads to foxes starving and soon dying.
Throughout 0 and 1000+ (key notes)	<p>When the foxes increase in population, the rabbits' population decreases right after.</p> <p>The rabbits also never become fully extinct since they have a higher reproduction rate and a higher initial count. Additionally, this may be because they might have developed survival instincts that help them stay alive.</p> <p>This pattern of rabbits learning to survive and stay alive, and foxes rapidly rebounding in population, keeps occurring.</p>

Time series plot & observations:



Generation	Observations
Around 0 - 40	Rabbits (blue) start at 200, foxes (orange) at 25. Rabbit population rapidly increases as they feed on grass. The fox population is almost extinct due to its inability to hunt properly.

Around 40 - 90	Rabbit count goes down as surviving foxes hunt more prey. Foxes start growing rapidly.
At around 750	The fox count to rabbit count ratio is such that there are insufficient rabbits for the fox to hunt. Foxes starve and decrease, rabbits feed on abundant grass and repopulate.
Around 90 - 1000	The pattern repeats: rabbits' peak in growth is followed by a peak in foxes' growth

Interpretation and analysis of time series:

- The Rabbits never die out since they reproduce quickly and feed on grass that is abundant. Foxes are on the verge of extinction, but they never disappear. They survive without eating for 20 generations and also move 3 steps in every generation, giving them the advantage to hunt.
- We see a cycle that repeats itself: the grass grows → rabbits grow → foxes grow → both animal population falls. The tuned assumptions prevent the rabbits from dominating and the foxes from dying out. It resembles the classic Lotka-Volterra predator-prey model.
- The regrowing patchy grass attracts the rabbits, which attracts the foxes towards the rabbit clusters. There is a sharp decrease in the rabbit count before the fox count reaches its peak.
- In rare instances, foxes crash because they prey excessively and grow, decreasing rabbit count (their food). They recover once the rabbits recover.