Fox vs. Rabbit: A multi-species ecological simulation

DS 3500 - Jeffrey Pan, Kathryn Warren, and Kaito Minami

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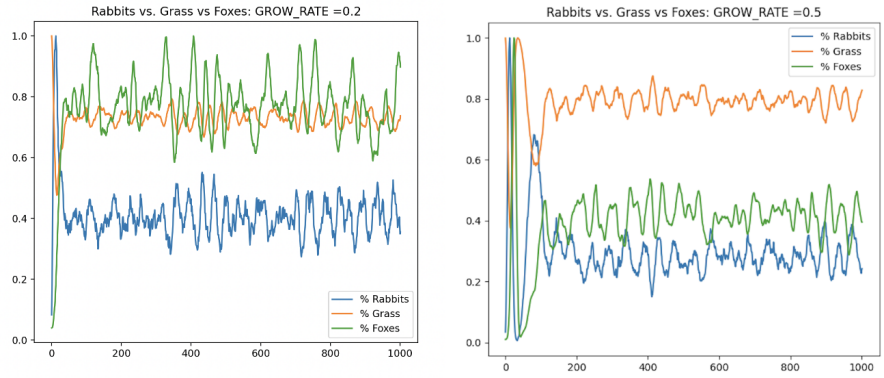

Figure 1 - Percentages of population density of fox, rabbit, and grass populations. Initial fox and rabbit populations are 100 individuals each. In these two subplots, the number of generations a fox can survive without eating (k) is 10, and the growth rate of grass is 0.2 (left) and 0.5 (right). The field dimension is 100 x 100 units.

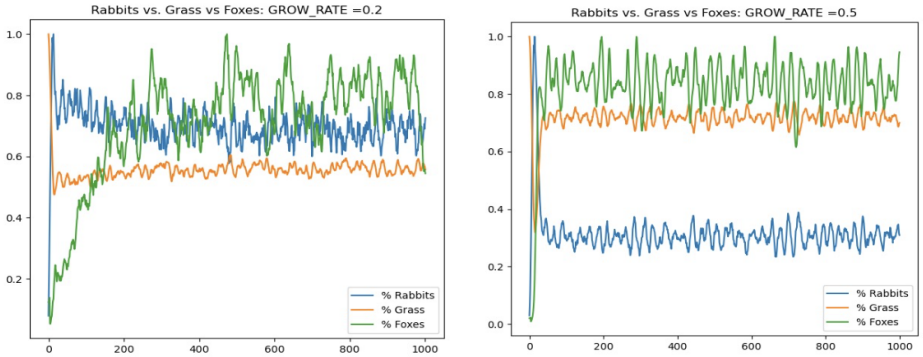

Figure 2 - Percentages of population density of fox, rabbit, and grass populations. Initial fox and rabbit populations are 100 individuals each. In these two subplots, the number of generations a fox can survive without eating (k) is 5, and the growth rate of grass is 0.2 (left) and 0.5 (right). The field dimension is 100 x 100 units.

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Introduction:

To explore the relationships between foxes and rabbits within a plot of land, simulations were conducted and Figures 1 and 2 were generated based on certain parameters, such as fox populations, rabbit populations, grass field size, grass regrowth rate, and the number of generations (k) that a fox can survive without eating rabbits. To standardize the parameters and keep the simulations consistent, fox and rabbit populations were kept at 100 individuals while the field size remained a 100 x 100 plot. With these static parameters (which can be changed by the user), foxes and rabbits developed a sinusoidal relationship that lasted all 1000 generations. With population and field sizes set to consistent values throughout the simulations, further insights on the influence k and the grass regrowth rate have on the populations can be deduced.

Which species is better able to survive?

According to the subplots in Figures 1 and 2, foxes had the highest maintained percentages of their maximum population, having higher population percentages than their rabbit counterparts. In Figure 1, between differing growth rates for the grass of 0.2 and 0.5 and k = 10, foxes had an average population percentage of around 80% and 40%, respectively. For rabbits, 40% and 30%, respectively. In Figure 2, between differing growth rates for the grass of 0.2 and 0.5 and k = 5, foxes had an average population percentage of around 80% and 90%, respectively. For rabbits, 70% and 30%, respectively. Foxes were able to maintain their high percentage of the population despite changes in grass growth rates and how many generations they can survive without eating. This maintenance of high percentages could be attributed to a smaller field size of 100 x 100, which enabled fox populations to remain relatively close to their prey.

Does your outcome depend on the size of the field or the rate at which grass grow or the fox k value? If so, how?

The outcome of the simulations found in Figures 1 and 2 are dependent on a combination of field size, the grass growth weight, and the fox k value. As the field gets larger and the population sizes remain the same, the chances of foxes being able to consume rabbits decrease, leading to a higher probability that they will go extinct within the 1000 generations being simulated. With a consistent field size of 100 x 100, increasing the grass growth rate actually caused an increase in fox populations. With a field that quickly replenishes grass, rabbits are able to consume and reproduce at higher rates, but with foxes consistently nearby due to the field size, it allows them to increase in population while maintaining rabbit populations (Figure 1). According to Figure 2, a decreased k value from 10 to 5 yielded a higher fox population, despite decreased survivability. This can be attributed to the smaller field size of 100 x 100. If the field were larger, and rabbit and fox populations were more spread out from one another, there could be a higher chance of fox populations not being able to sustain themselves due to a lack of prey. The growth rate, field size, and k value are all interdependent with one another, a larger field size would slightly reduce the need for grass growth rate, but a smaller field size would need a higher growth rate to sustain rabbit and fox populations. As the field is larger, foxes that are able to live longer without eating (higher k value) are able to reproduce and eat more successfully, while the field becomes smaller. The growth rate is increased, and k's influence decreases significantly.