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8.2.6 Rabbits and foxes

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MO2.4

Differential equation models have also been used to study the dynamics of populations of predators and prey. For example, consider the population of foxes and rabbits in a forest. Let $f(t)$ and $r(t)$ represent the number of foxes and rabbits, respectively. A common predator-prey model, known as the Lotka–Volterra model, is the following pair of differential equations:

$$\frac{\mathrm{dr}}{\mathrm{d}t} = a\mathrm{r} - b\mathrm{r}\mathrm{f} \tag{8.28}$$

$$\frac{\mathrm{df}}{\mathrm{d}t} = -m\mathrm{f} + c b \mathrm{r}\mathrm{f} \tag{8.29}$$

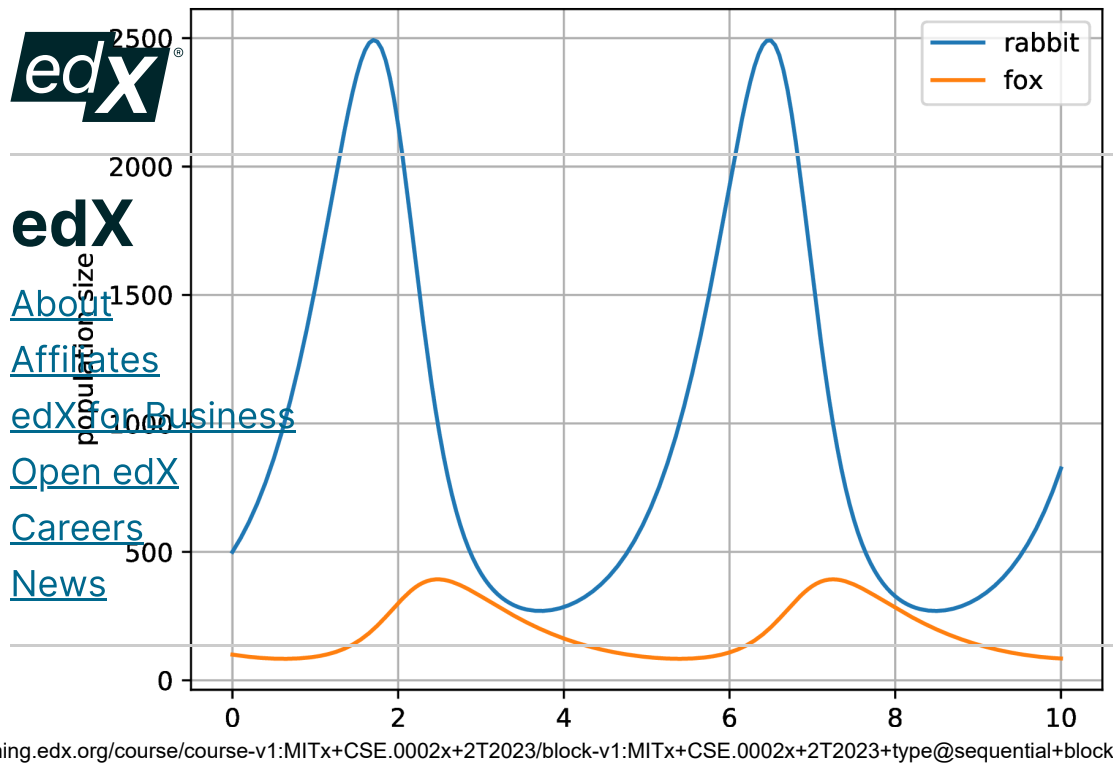
where a, b, c, and m are non-negative. The coefficient a represents the rate at which the population of rabbits grows as a proportion of the current number of rabbits (if there were no foxes). Similarly, the coefficient m represents the mortality rate of the foxes (if there were no rabbits). The coefficient b represents the predation rate based upon the number of possible encounters between rabbits and foxes. And the coefficient c is known as a conversion efficiency and quantifies the rate at which a predation increases the prey's population.

As an example, consider the following scenario,

$$a = 2.0\,\mathrm{month}^{-1}, \quad c = 0.1\mathrm{foxes/rabbits}, \quad \mathrm{r}(0) = 500\,\mathrm{rabbits}$$

$$b = 0.01\,(\mathrm{fox\,month})^{-1}, \quad m = 1.0\,\mathrm{month}^{-1}, \quad \mathrm{f}(0) = 100\,\mathrm{foxes}$$

The results in Figure 8.7 demonstrate how as the population of foxes increases, the population of rabbits decreases until eventually the number of rabbits is too small to support the number of foxes. This causes the population of foxes to decrease and eventually leads to a recovery of the rabbit population. The model produces periodic behavior.



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