

# Study of Predator-Prey Dynamics

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April 13, 2025

## Lotka-Volterra Model (LVM)

The Lotka-Volterra Model (LVM) models the dynamics between a predator species ( $y$ ) and a prey species ( $x$ ) over time ( $t$ ).

$$\frac{dy}{dt} = -ay + bxy \quad \frac{dx}{dt} = +dx - cyx$$

The model depends on four parameters.

- $a$ : decay rate of the predators
- $b$ : proportionality for how predators grow due to eating prey
- $c$ : proportionality for how prey decay due to being eaten by predators
- $d$ : growth rate of the prey

Dividing the differential equations by each other yields  $\frac{dy}{dx}$ .

$$\frac{dy}{dx} = \frac{b y \left( x - \frac{a}{b} \right)}{c x \left( \frac{d}{c} - y \right)}$$

Since this equation does not depend explicitly on time, it can be used to create phase portraits. The solutions swirl counter-clockwise around  $x = \frac{a}{b}$  and  $y = \frac{d}{c}$ .

## Types of Simulation Outcomes

### Conditions for Good Modeling

### Main Simulation Parameters

`breed_time`

`energy_gain`

`breed_energy`

### Circular Initialization

### Extension