

## Differential Equations

The system of equations representing the interaction between humans ( $H(t)$ ) and aliens ( $A(t)$ ), considering alien-induced diseases and crop impact, is given by:

$$\frac{dH}{dt} = r_H(1 - \delta_F)(1 - \text{cropImpact})H - \delta_D H A$$

$$\frac{dA}{dt} = r_A A - \gamma A - \lambda H$$

Where: -  $r_H(1 - \delta_F)(1 - \text{cropImpact})$  is the effective human population growth rate, accounting for fertility reduction and crop impact. - If the effective growth rate becomes negative, it is set to zero to prevent unrealistic behavior.

## Constants and Their Meanings

- $r_H = 0.03$ : Human population growth rate (birth rate).
- $r_A = 0.005$ : Alien population growth rate.
- $\gamma = 0.00001$ : Alien death rate due to environmental adaptation challenges.
- $\lambda = 0.00002$ : Alien death rate due to human resistance.
- $\delta_D = 0.00001$ : Disease-induced human mortality rate caused by alien diseases.
- $\delta_F = 0.5$ : Reduction factor for human fertility due to alien-induced diseases.
- $\text{cropImpact} = 0.4$ : Reduction in human population growth rate due to alien crop impact.

## Terms in the Equations

- $r_H(1 - \delta_F)(1 - \text{cropImpact})H$ : Human population growth rate, adjusted for fertility reduction and crop impact.
- $-\delta_D H A$ : Loss of human population due to alien-induced diseases.
- $r_A A$ : Natural alien population growth.
- $-\gamma A$ : Alien losses due to environmental adaptation challenges.
- $-\lambda H$ : Alien losses due to human resistance.

## Initial Conditions and Simulation Details

- Initial human population:  $H_0 = 500$ .
- Initial alien population:  $A_0 = 200$ .
- Time span:  $t \in [0, 500]$  days.