*Gourav Khadge and Leif Park Jordan*

Getting Started: Model Reference Adaptive Control of Satellite Orientation

This GUI displays a visualization of adaptive control in stabilizing a satellite’s orientation.

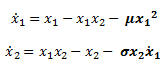
The *Volterra-Lotka* predator prey model is the standard model of ecosystem dynamics that assumes:  
1. logarithmic population growth rate   
2. linear predator growth and prey decline proportional due to predation to the opposing population

**The model expansion adds two additional terms:**

**3. Disease and overcrowding in prey (represented by parameter μ)**

**4. First order time delay for predator growth (represented by parameter σ)**

The terms we add to the *Volterra-Lotka* predator prey model are bolded below:

https://lh5.googleusercontent.com/BTjF9xobSynbbOYiG9Z8bG7eFLjWyPumo-rbX7hJbQtfFIHNUBOD0k1YNDOS_FNkeHzFLxXWHf9wh5iTdUyCfGQMfBl_W9wKxGc9SW65rgXSX-5ebeH7bNmtXBkV_367uw

To understand this expanded model, the provided GUI plots phase portraits and time plots of predator-prey populations with various initial conditions and parameter values.

**Parameter Inputs**

Parameters **μ** and **σ** can be input in three ways:

1. Clicking directly on the parameter space plot

2. Using the provided sliders

3. Entering the parameters directly

These parameters are limited to values between 0 and 2. Try values close to the red line!

**Initial populations** and the **simulation time span** can be input by clicking the appropriate *Edit* buttons. These can be reset to default by clicking their respective *Default* buttons. The **Input populations** can also be input by clicking directly on the phase portrait plot. The time span is limited to a minimum of 1 and a maximum of 300. The initial populations are limited to a minimum of 0 and a maximum of 1 for each species.

**Outputs**

All outputs will automatically update upon any change to the input parameters.

The **Phase Portrait** and **Time Evolution** plots reflect the ecosystem developments from the given initial conditions for a duration given by the time span input. Red circles on the **Phase Portrait**indicate fixed points.

The **Results Table** in the lower left corner of the GUI will display the relevant stable point of the system (stable point in the area the system approaches over time) and its stability classification (Stable node, Stable focus, Limit cycle). If a limit cycle is predicted, the GUI will tabulate a predicted approximate limit cycle period based on the parameters, and tabulate the measured limit cycle period.

**Other Features**

The “Hold Current Axis Limits” box can be checked to preserve the output graphs’ current axis limits if parameters change.