Tommy Trakoolthai

trakool@pdx.edu

February 4th, 2025

Project Proposal: Simulating the Lotka-Volterra Model

Topic Area

Differential equations, mathematical biology

Motivation

The Lotka-Volterra (predator-prey) model is a first-order, nonlinear differential equation that many students are introduced to in their elementary differential equations course. The model is given by the following equations:

$$\frac{dr(t)}{dt} = \alpha r(t) - \beta r(t) f(t)$$
$$\frac{df(t)}{dt} = \gamma r(t) f(t) - \delta f(t)$$

Very simply, if the variable, *r*, represents some prey population (rabbits) and the variable, *f,* represents some predator population (foxes), then the system describes how their respective populations change over some time *t*. This system is easily solved using techniques from elementary differential equations, leading to a deterministic and continuous solution. However, we hardly (if ever) see such behavior in a real-world scenario, which can be described to be stochastic. Using a probability generating function, we can obtain a stochastic version of the above model and simulate what the solution might look like.

The deterministic solution is well-known and readily available from many online sources. The stochastic solution obtained from a probability generating function is a result of prior

research. I have simulated both the deterministic and stochastic solutions using MATLAB, but for this project, I would like to create the same simulations using Rust.

Vision

After obtaining a working simulation for both the deterministic and stochastic versions, I would like to develop a GUI that would let users edit the system's parameters. The GUI would ideally simulate how the prey and predator populations change over time. Additionally, I would like to extend this project by implementing my own ODE solver (based on Runge-Kutta) in Rust to solve the deterministic system.

Concerns

I have little knowledge and experience with Rust ODE solvers and its ability to create plots and GUIs. I will need to research these areas heavily, as that will likely be the difficult part of the project.