Modeling Complex System - MC_SYS

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Introduction

- This project explores predator-prey dynamics using mathematical modeling and agent-based simulations.

Implementing Real-world systems that have randomness using Discrete-Time Model with Randomness.

Existing Model: Lotka-Volterra Model

- Uses differential equations to model predator-prey interactions.
- Assumes constant birth/death rates, no randomness.

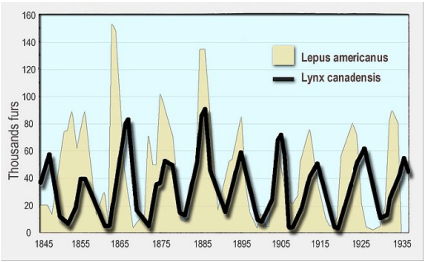
Our Model: Discrete-Time with Randomness

- Discrete-time update instead of continuous equations.
- Random variations in predation and birth rates.
- Includes spatial constraints (creek as a safe zone for rabbits).
- Agent-Based Modeling (ABM) for spatial interactions.

Methodology

Simulation is done in two parts : Equation based and Agent based Models.

Predator Prey Dynamics in Real- World



(Source: Wikipedia.)

Image credit: Wikipedia

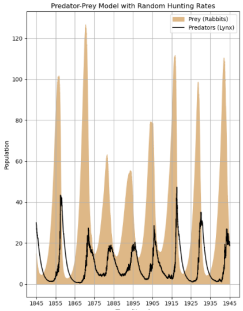


Image credit: Simulation from Program

Phase Plot :

- Maps rabbit population against lynx population
- Chaotic behaviors can be observed.

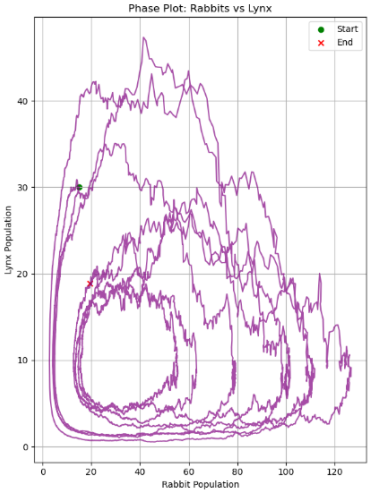


Image credit: Simulation from Program

Agent Based Model

- Live Simulation where agents move dynamically.
- Introduction of non-hunting zone
- Animation with 20 frames.
- Updates every 20milliseconds.
- Save it as a GIF/Video.

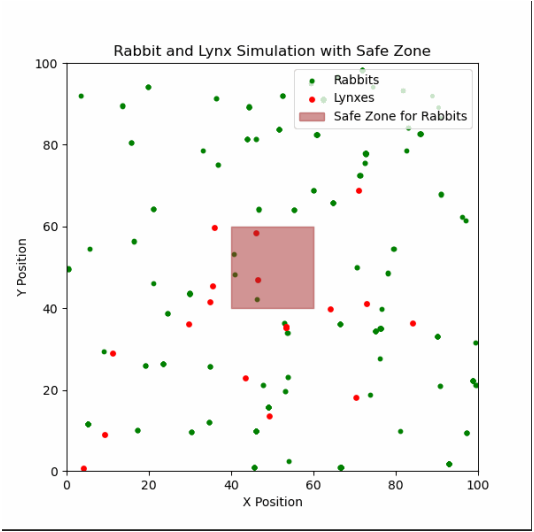


Image credit: Simulation from Program

Conclusions And future work

- Our model improves realism by adding randomness spatial constraints.
- Creek zone affects predator-prey interactions.
- Future works: Add seasonal variations, multiple predator-prey species, 3D simulations.