Group 4
Laboratory Works 6 Report

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Experiment nulll

I. Modeling Process (including assumptions)

In this model, we aim to simulate the interactions between predators and prey within a simple ecosystem. The model will focus on the population dynamics driven by behaviors such as random movement, hunting, and reproduction. By varying different parameters, we can observe how these interactions influence the stability and sustainability of the ecosystem.

Objectives

1. **Simulate Predator-Prey Dynamics**: Create a realistic model that captures the interactions between predators and prey within a grid-based environment.
2. **Behavioral Mechanisms**: Incorporate the behaviors of random movement and reproduction for prey, and hunting, energy consumption, and reproduction for predators.
3. **Population Analysis**: Analyze the population trends of predators and prey over time to understand the impact of different parameters on the ecosystem's stability.

Expected Outcomes

1. **Population Trends**: Visualize the changes in predator and prey populations over time, highlighting periods of growth, decline, and equilibrium.
2. **Behavioral Impact**: Understand how different behaviors and parameters (e.g., reproduction rates, energy consumption) affect the population dynamics.
3. **Ecosystem Stability**: Identify conditions under which the ecosystem remains stable or becomes unstable, leading to the extinction of predators, prey, or both.

II. Model Construction

Constants and Parameters

1. width = 20
   - Width of the simulation grid.
2. height = 20
   - Height of the simulation grid.
3. initial_prey = 50
   - Initial number of prey agents.
4. initial_predators = 5
   - Initial number of predator agents.
5. prey_reproduction_rate = 0.2
   - Base reproduction rate for prey.
6. initial_predator_energy = 20
   - Initial energy level for predators.
7. energy_gain = 10
   - Energy gain for predators when they consume prey.
8. predator_reproduction_energy = 40
   - Energy threshold for predator reproduction.
9. Max steps = 100
   - Duration of the simulation in steps.

Model Agents and Dynamics

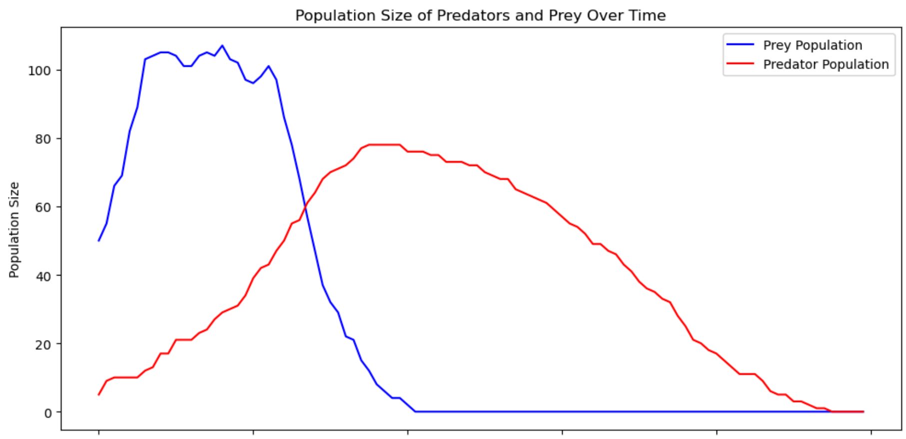
1. Prey Agent
   - Moves to a random neighboring cell and reproduces based on a dynamic rate.
2. Predator Agent
   - Moves towards prey if nearby, consumes prey to gain energy, and reproduces based on its energy level.
3. PredatorPreyModel
   - Initializes the grid and agents, collects data on prey and predator populations, average predator energy, and predator-prey encounters.

Simulation Execution

1. run_model_and_collect_averages(model, steps)
   - Runs the simulation for 100 steps and collects average statistics on:
     - Average Prey Population
       - Calculated over the simulation duration.
     - Average Predator Population
       - Calculated over the simulation duration.
     - Average Predator Energy
       - Calculated over the simulation duration.
     - Average Predator-Prey Encounters per Step
       - Total encounters divided by the number of steps.

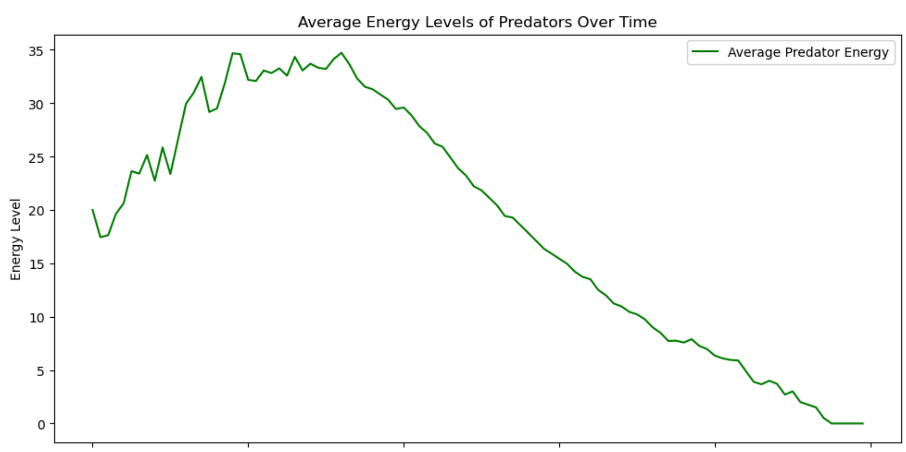
III. Simulation Results

Population Dynamics



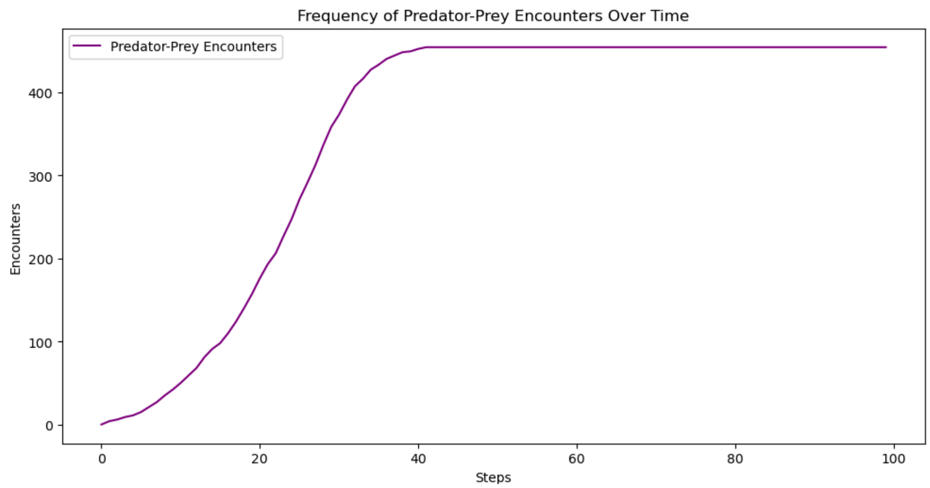
In the simulation, the population dynamics of predators and prey are interdependent but exhibit distinct patterns. Initially, the prey population is set to 50, while the predator population starts at 5. Due to the low initial predator population, the prey reproduce exponentially.As the prey population grows, predators find ample prey to consume, which leads to a rapid increase in their energy levels and, consequently, their reproduction rate. This surge in predator numbers exerts pressure on the prey population, leading to a decline in prey reproduction and numbers. Eventually, the predator population becomes so high that the prey cannot reproduce quickly enough to sustain their numbers. As a result, the prey population plummets, ultimately leading to their extinction. Without sufficient prey to consume, the predator population also begins to decline and eventually becomes extinct.

Average Energy Level : Predator



The average energy level of predators fluctuates based on prey availability and the dynamics of predator reproduction and consumption. Initially, predators have sufficient energy due to the abundant prey population. As predators consume prey, their energy levels increase, enabling reproduction. Over time, as the predator population grows, prey availability decreases, leading to a decline in predator energy levels as predators expend more energy searching for food, resulting in fewer successful hunts and lower overall energy. When the prey population becomes critically low, predators can no longer sustain themselves, leading to a further decrease in their energy levels. This cycle continues until the prey population is too low to support the predator population, resulting in the eventual extinction of both species.

Frequency Encounter



In the simulation, the frequency of encounters between predators and prey initially increases gradually over time. This is due to the initially high prey population, which provides ample opportunities for predators to find and consume prey, leading to more frequent encounters. As predators reproduce and their numbers increase, they continue to encounter prey more often.However, around time step 40, the prey population begins to decline significantly due to the high predation pressure. With fewer prey available, the frequency of encounters between predators and prey starts to decrease. This decline continues until there are no more prey left for the predators to encounter, resulting in a complete cessation of encounters. This pattern reflects the interdependent dynamics of predator and prey populations, where an initially abundant prey population supports a growing predator population, which eventually leads to a depletion of the prey and subsequent decline in predator-prey encounters.

IV. Conclusion

The predator-prey simulation reveals the intricate dynamics between predator and prey populations, illustrating a cyclical pattern of interdependence. Initially, the prey population grows rapidly due to low predation pressure, which supports a rise in the predator population as they reproduce from ample food sources. However, as the predator population increases, the pressure on prey intensifies, leading to a decline in their numbers. Encounters between the two initially rise but drop around time step 40 as prey become scarcer, signaling a critical phase where the prey population can no longer sustain the predators. This imbalance results in a sharp increase in the predator-prey ratio, highlighting the growing difficulty predators face in finding food, leading to decreased energy levels and a subsequent decline in the predator population. The simulation underscores the delicate balance in natural ecosystems, demonstrating how rapid population changes can occur in response to shifts in predator and prey availability.