The Dynamics of Clustering in Predator-Prey Interactions

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Introduction and Background

Does Cooperation via Clustering affect Survival of Preys?

We propose that, initially, more cooperative preys have an advantage in increasing population due to feasibility in finding food sources by relying on their fellow members. They also become more prone to predation as they are more readily exposed to predators as soon as their fellow members are attacked, leading to sharper decreases in population.

Methodology and Model

Prey (flocking, gain/lose energy)

- Move towards food particles to consume nutrients.
- Share gains equally when adjacent to the same particle.
- Lose energy each timestep and die when energy depletes.
- Flee from predators within visual range.

Predators (eat prey)

- Move directly towards prey within visual range
- Wander randomly if no prey is nearby

Nutrients (replenish prey energy)

- Stationary
- Consumed by prey for energy
- Regenerate next to existing ones if under carrying threshold

Simulation Process

Prey decision-making schema:

1. Evade predators
2. Look for food
3. Cluster
    a. Affected by the Visual Range of the agents

Boids- Allows for clustering

Separation:
- Boids try to maintain a minimum distance from their neighbors to avoid collisions
- Each boid adjusts its velocity based on the repulsion forces from nearby boids

Alignment:
- Boids attempt to align their velocities with the average velocity of their neighbors
- This rule fosters a sense of cohesion within the flock

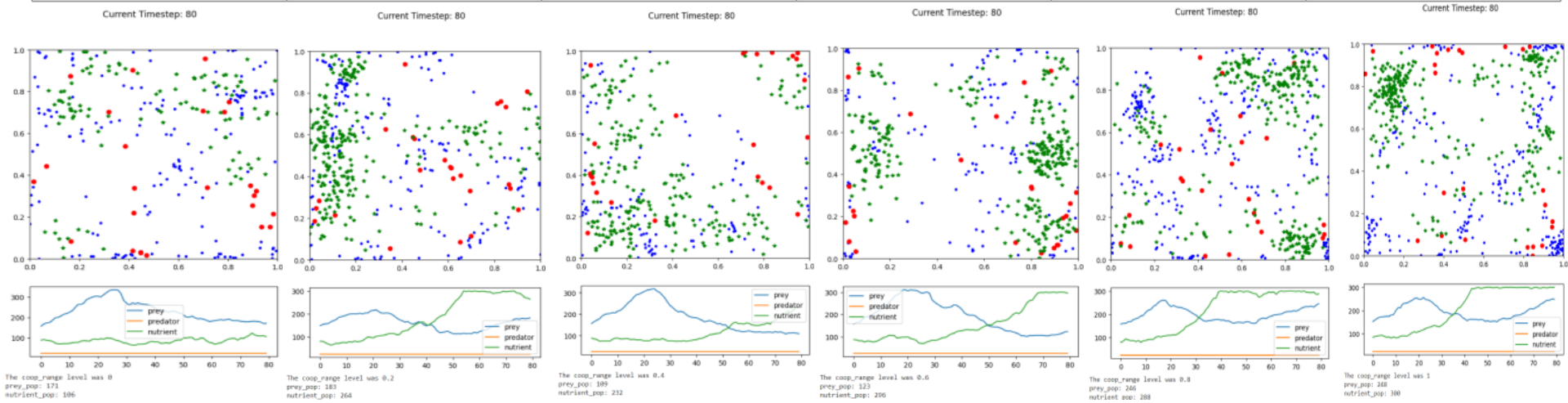
Cohesion:
- Boids move toward the average position of their neighbors
- This rule encourages boids to stay close to each other, contributing to the overall cohesion of the flock

* Visual Range*:
- Boids determine what other boids are taken into consideration during the model
- This rule affects flock density, spacing, and the overall appearance of the simulated flock.

Results

Cooperation Level

0	0.2	0.4	0.6	0.8	1

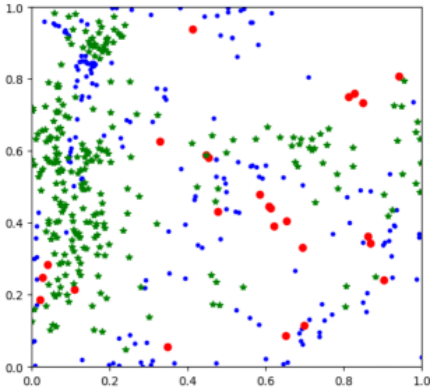


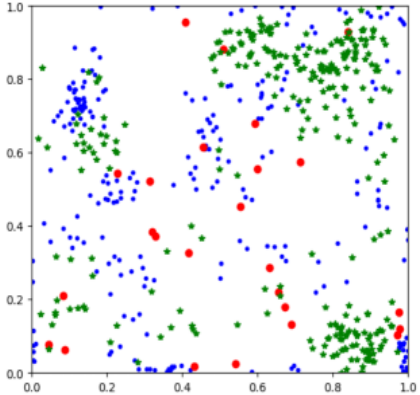
Average Survival Rate based on 5 trials

167.4	165.8	117	118	223	225.4

Discussion and Implications

- Cooperativity level between 0.8 and 1 facilitates the highest prey survival, attributed to enhanced abilities in finding food and evading predators
- Larger clusters can’t form due to the decision-making process carried out by each prey
- Clustering seems to emerge by virtue of preys following simplistic behaviour





clustering level: 0.2 0.8

Literature

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Thank you!