

The Dynamics of Clustering in Predator-Prey Interactions

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Abstract

- Our project explores the dynamics of cooperative clustering behavior in prey and its impact on survival within a predator-prey ecosystem.
- Utilizing an agent-based model, we simulate interactions among prey, predators, and nutrients in a two-dimensional space.
- Our findings reveal that varying levels of prey cooperativity significantly influence survival rates, with optimal cooperation observed in specific ranges.

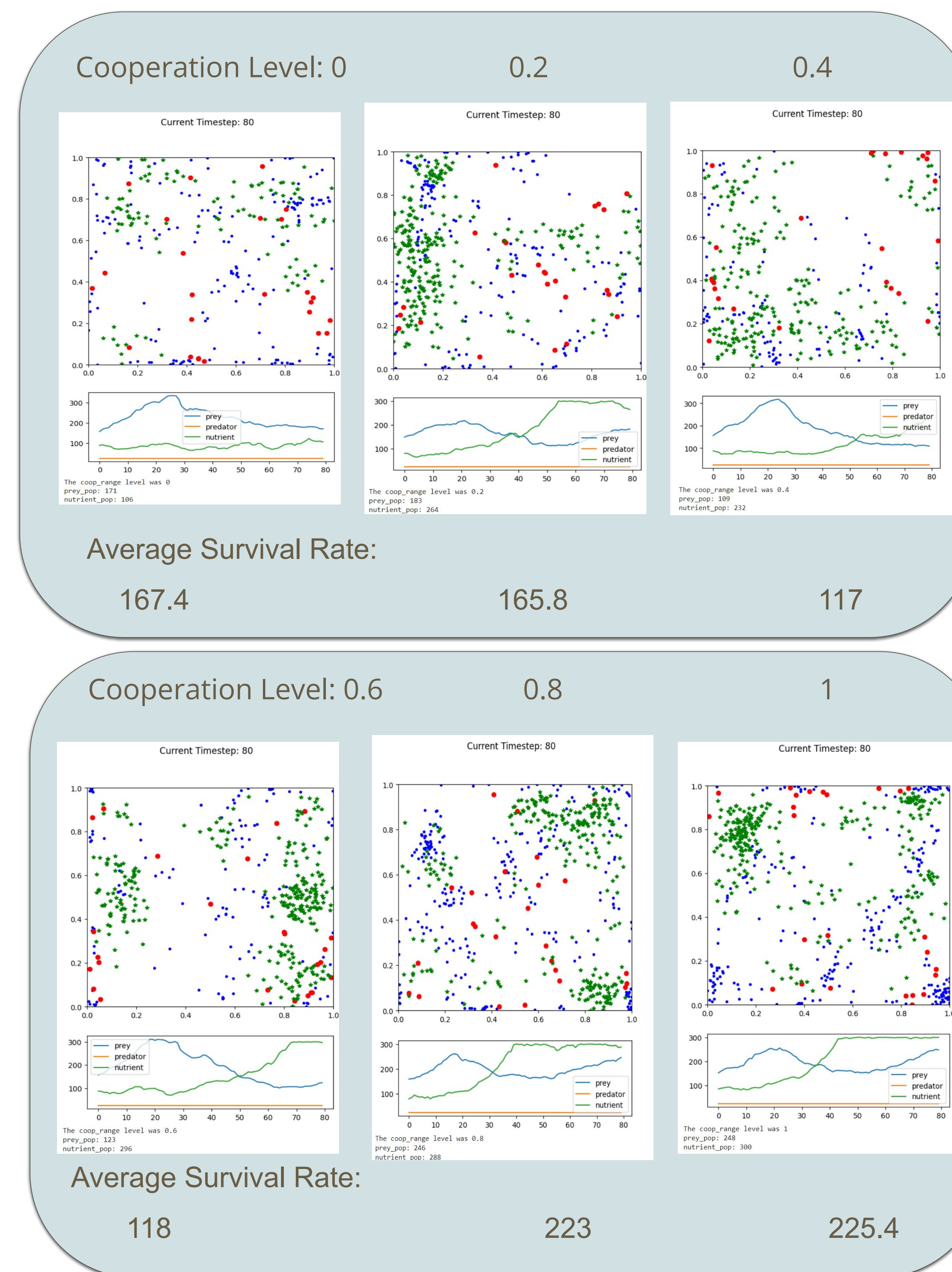
Introduction

- Background
Cooperative behaviors in groups of organisms, such as wolf packs and fish schools, offer survival advantages.
- Objective
To investigate the role of cooperative behavior ('packing') in prey survival, particularly how it affects vulnerability to predation and efficiency in resource utilization.

Methods

- Model Overview
A dynamic agent-based model with three agent types: prey, predators, and nutrients.
- Agent Behaviors
 - Prey
Flocking behavior based on boids model principles (separation, alignment, cohesion), energy-dependent reproduction, and nutrient-seeking.
 - Predators
Direct movement towards prey within visual range.
 - Nutrients
Stationary resources consumed by prey for energy.
- Simulation Environment
Two-dimensional wrapped space, 80 timesteps per run.

Simulations and Results



- Survival Trends:
 - Cooperativity levels of 0.8 to 1 yield the highest prey survival rates.
 - Lower (0 to 0.2) and higher (1.2) cooperativity levels show decreased survival.
 - Intermediate levels (0.4 to 0.6) result in the lowest survival rates.
- Implications:
 - Optimal cooperativity enhances group protection and resource-finding efficiency.
 - Excessive cooperativity can lead to diminishing returns in survival benefits.

Implications

Key Findings:

- A balance in cooperative behavior is crucial for maximizing prey survival.
- High cooperativity aids in evading predators and efficient foraging.
- Over-clustering at very high cooperativity levels can be detrimental.

Broader Impact:

- Insights into ecological management and conservation strategies.
- Understanding the balance of individualistic and group behaviors in ecological systems.

Conclusion

Our study underscores the critical balance in cooperative behavior among prey in predator-prey ecosystems. While a certain level of cooperation is beneficial for survival, there is a threshold beyond which it becomes counterproductive.

- 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

Limitations:

- Has only one prey-predator interaction
- Cooperation levels does not depend on just visual range

Acknowledgements

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