Justin Carmichael
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Project Abstract

Mentors: Eric Libby and Andrew Berdahl

Balancing Foraging and Predation: The Evolution of Collective Behavior in Fish

Many species of fish move as a group in order to maximize survivability. Collective motion allows schools of fish to more efficiently find food and avoid predators. We will use a simulation to examine how collective behavior evolves, and how different types of collective behavior affect survivability. The project will involve several phases.

The first phase of the project will involve only one type of fish and a stationary food source. We will analyze how changing the behaviors of the fish affect how efficient they are at locating and exploiting food sources. We will use several different distributions of food to compare how effective each set of parameters is in different situations.

The second phase will involve one type of fish and a moving food source. We will once again analyze the effect of changing the behaviors of the fish on how efficient they are at locating and exploiting food sources. This phase will also examine the performance of the fish on several food distributions.

The third phase will introduce a second type of fish ($fish_2$) that will prey on the first type of fish ($fish_1$). Here we will try to find the behaviors that allow $fish_1$ to be most successful while being hunted by $fish_2$. $Fish_1$ will have to balance searching for food while at the same time trying to avoid being eaten by $fish_2$. We will test both stationary food and mobile food as well as different distributions of both types of food.

The fourth phase will be the same as the third phase except it will allow the fish to evolve. When a member of a fish population either starves to death or is eaten by a predator, a new fish will be “born” to replace it. The new fish will take its parameters from another random fish in the population and there will be a small chance of one of the new fish's parameters mutating. We will run simulations with evolution to try to find an optimal configuration of behaviors.

The fifth and final phase will be the same as the fourth phase, but will add a third type of fish ($fish_3$) to the simulation. This will add more complexity to the simulation, which we expect will cause a domino effect of behavior change. $Fish_2$ will likely have to change its behavior in order to avoid $fish_3$. We suspect this will cause $fish_1$ to change its behavior to optimize its own strategy against $fish_2$'s new strategy.

Using the above simulations, we hope to further show the circumstances and mechanisms through which collective behavior in fish may have developed.