The Boid on the Wire:
Modeling Bird Flocking & Interaction with Power Lines

COMP 3106 A – Project Proposal

Group 72
Petra DeBat, 101183615

November 1, 2024

Introduction and Background

Have you ever thought about if the government is spying on us through bird robots? Well, this project will investigate how birds fly and sit on power lines to possibly do just that.

The boids algorithm, created by Craig Reynolds in 1986, is a model for simulating flocking behaviour in animals. Boids follow three rules: alignment, cohesion, and separation which together produce realistic, emergent group behaviours. These rules guide each boid (agent) to align with nearby individuals, move towards a group center, and avoid crowding.

This project will extend the boids model to simulate the unique group dynamics of birds gathering on a powerline. In this setting, birds periodically land to rest and then take flight together when they become restless. This collective behaviour shows how simple agents (birds) interact with each other and external stimuli (power lines as resting spots, fatigue, restlessness) to create complex, realistic group patterns. By simulating this behaviour, we hope to explore the environmental and social cues that influence birds' collective actions, such as the decision to rest or take off in unison.

Proposed Objectives

Primary Objective: Simulate the behaviour of large groups of birds as they gather on a powerline when tired and depart in unison when they become restless.
Secondary Objective: Analyze how group dynamics, such as synchronization in landing and taking off, emerge from simple behavioural rules influenced by environmental factors like fatigue, restlessness, and the presence of a powerline.

Proposed Methods of AI

This project is partly inspired by the assignment suggestion "path planning in multi-agent environments". It takes "path planning" to mean movement around an environment based on external inputs, and the "multi-agent environment" is how each bird perceives its environment instead of having global knowledge of the goals/knowledge of each other bird.

Modified Boids Algorithm:

The project will adapt the boids model to reflect birds' unique resting and departure behaviours on a powerline. In addition to standard flocking rules (alignment, cohesion, and separation):

- **Fatigue and Rest States**: Each bird will have a fatigue level that influences its decision to land or leave. As fatigue increases, birds are more likely to land on the powerline. Resting on the line will reduce fatigue over time.
- **Restlessness Threshold**: After a set period, a restlessness parameter will increase, prompting birds to leave the powerline. This creates a natural cycle of arrival and departure, simulating the observed pattern of birds moving as a group.

Environmental Awareness and Social Influence:
Birds' behaviour will be influenced by nearby birds' states. If a critical mass of birds shows restlessness, others are more likely to take off, creating a synchronized departure effect. This can be achieved by adjusting each bird's restlessness threshold based on the activity of neighbouring birds.

Dataset to be Used & Proposed Validation/Analysis Strategy

Although this simulation does not rely on a specific dataset, we want to use online videos to compare how our approach matches real-life examples. There are several YouTube videos that helped inspire this project, "I Didn't know Birds use Math in Murmurations!" by the channel "SmarterEveryDay", and "Coding Adventure: Boids" by the channel "Sebastian Lague", which will also be used as a reference.

Project Novelty

Boids are often used to simulate the flocking behaviour of groups, but the fundamental rules don't extend their state machine past just the path of their movement. By adding extra behaviours, we hope to be able to simulate how birds operate as a large group while not flying. We hope to find some emergent behaviour, such as synchronized departure, and distributing landing along the powerline.

Weekly Schedule
Week 1 (Nov. 4 - Nov. 10): Literature review, initial 2D boids math
Week 2 (Nov. 11 - Nov. 17): Finish boids implementation, add visual demo
Week 3 (Nov. 18 - Nov. 24): Add goals to simulate resting, tune to reach objectives
Week 4 (Nov. 25 - Dec. 1): Stretch goal time: 3D simulation, add extra behaviours
Week 5 (Dec. 2 - Demo Day): Project polish: Clean up visuals, fix bugs

Demo Availability
Wednesday December 4 – Friday December 6, 11 AM – 5 PM
Online Preferred.

GPU Resources
This project won't make use of training a model, so I don't think I'll need access to a GPU.

References

Reynolds, Craig W. "Flocks, Herds and Schools: A Distributed Behavioral Model." *Computer Graphics (New York, N.Y.)*, vol. 21, no. 4, 1987, pp. 25–34, https://doi.org/10.1145/37402.37406.