Framework for *Real-time Realistic* and *Interactive Simulations* of Animal Flocking

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Motivation

Flocking behavior of groups of animals is a fascinating natural phenomenon. In computer games, flocking simulations can enhance realism or create novel mechanics. However, building these systems can be challenging.

This thesis presents a framework for flocking in computer games. Flocking is deconstructed into a flexible, high-performance parallel pipeline. The pipeline's modular design allows designers to configure complex AI without writing code through a GUI, while programmers can easily extend the system with new logic.

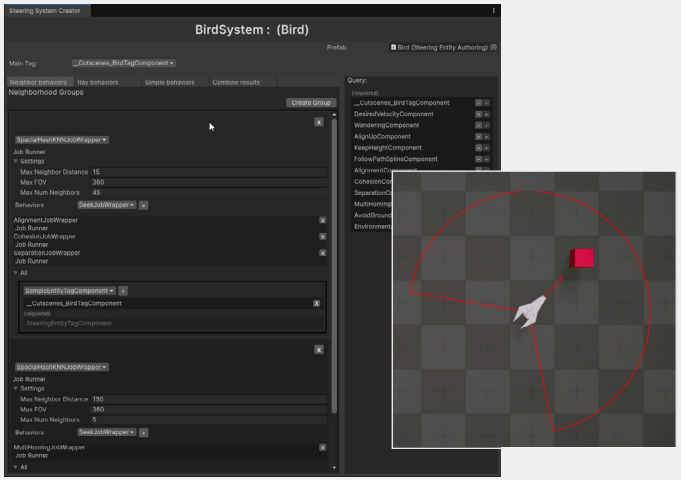
The thesis also makes a theoretical contribution with a novel method for blending behaviors using a "desire value," which gives fine-grained control when balancing conflicting goals.

Usage and Workflow

The framework is designed for both designers and programmers.

For Designers: A custom editor allows designers to build complex AI without code. They can set up what behaviors are used and tune all parameters in the UI.

For Programmers: Programmers can easily extend the framework by writing only the core logic for a new component of the pipeline. The system manages all parallelization and integrates new components (e.g. new behaviors) into the designer's editor.



Framework Architecture

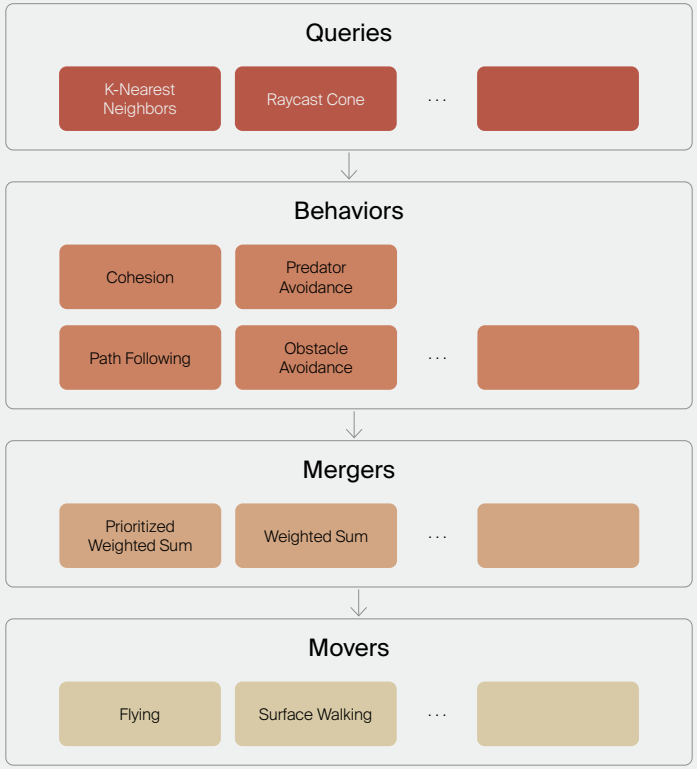
The framework is designed as an extensible, high-performance parallel pipeline, utilizing Unity's DOTS technology. An agent's logic is handled through main four components of this pipeline.

Queries: Responsible for collecting information about the environment. This stage uses efficient neighborhood searches to find other agents or raycasts to detect obstacles.

Behaviors: Generate reactions to the query data. Each behavior outputs a desired velocity and a "desire value" representing its urgency.

Mergers: The agent's decision-making core. It arbitrates between results of competing behaviors, blending their outputs based on priorities and desires to produce a single action.

Movers: Translate the final decision into movement. This stage defines the agent's mode of transport, such as walking or flying.



Result and Conclusion

The result of this thesis is a complete, high-performance flocking framework for Unity, built on a modular design that allows for easy extension by programmers and visual configuration by designers. It was validated in a complex game scene, simulating thousands of entities and successfully managing agents with 14 competing behaviors. Furthermore, the framework includes a large library of default components and multiple sample scenes to guide users.