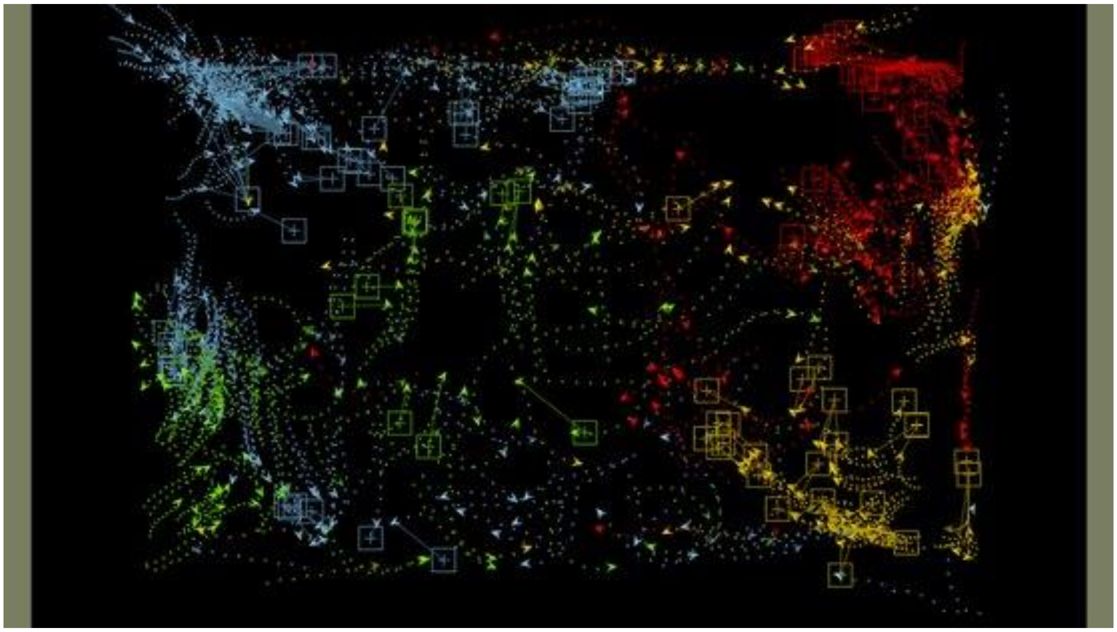
Report

BSc Computer Science (Artificial Intelligence)



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Observations of 10 Boids Simulation

In the simulation, boids display diverse positions and velocities, revealing various movement patterns. Their avoidance of each other, influenced by separation behavior, is evident in widely spread X and Y positions. Cohesion behavior draws boids to the center, forming clusters, while alignment behavior aligns velocities for smoother movement. Constrained by specified radius and decision-making rules, the emergent flocking behavior showcases 10 boids navigating space cohesively, demonstrating the effectiveness of the implemented model in generating complex group dynamics.

Observations of 100 Boids Simulation

Boids demonstrate diverse positions, effectively avoiding collisions through separation behavior. Varied velocities indicate dynamic interactions, contributing to the flock's complex movement. Despite separation, cohesive clusters form under the influence of cohesion behavior. Boids remain within the specified outer radius, ensuring proximity. The emergent flocking behavior reflects collective responses to separation, cohesion, and alignment, resulting in smooth navigation and complex trajectories. Dynamic velocity changes highlight the adaptation to collective behavior. The diverse grouping of 100 boids captures the essence of Craig Reynolds' model, creating visually engaging group dynamics.

Observations and comparison of Separation & Cohesion, with 100 boids

Examining 100 boids, the behaviors of separation and cohesion yield notable findings. Simply put, separation means boids intentionally steer clear of nearby buddies, ensuring they have their own personal space. On the flip side, cohesion nudges them to gravitate towards the center of mass of their close pals. Each boid's speed varies because of these forces, and they tweak their direction to match their buddies. When in groups, boids tend to create dynamic clusters while still keeping some distance. The interplay of separation and cohesion results in motion that appears clustered but spread out. Compared to the original swarm, the harmony of separation and cohesion creates a visually engaging and lively swarm, forming dynamic clusters and encouraging boids to gather towards a shared center, boosting the overall unity of the swarm.

Observations and comparison of Separation & Alignment, with 100 boids

Examining 100 boids, separation and alignment behaviors unveil distinct observations. Boids actively avoid close neighbors, establishing clear avoidance patterns and preventing crowding. The alignment of velocities with nearby neighbors results in varied individual velocities due to separation forces. Group dynamics manifest in dynamic spacing, with boids maintaining considerable distance between each other, forming multiple smaller clusters propelled by separation forces. Emergent patterns reveal distributed motion, preventing large cohesive groups, and dynamic adjustments as boids continuously respond to proximity, creating dynamic patterns. Compared to the original swarm, separation and alignment foster increased spacing, dynamic clusters, and individualistic movements, generating a visually distributed and dynamic swarm behavior.

Observations and comparison of Cohesion & Alignment, with 100 boids

Observing 100 boids, cohesion and alignment behaviors manifest distinct group dynamics. Cohesion draws them to the mass center, forming cohesive clusters, while alignment synchronizes velocities for coordinated movement. Within clusters, stable formations arise, highlighting strong cohesion. Dynamic coordination maintains relative positions, contributing to overall group movement in a unified direction. The emergent patterns showcase a balance between staying together and coordinated movement. Compared to the original swarm, enhanced organization emerges, with stronger cohesion evident in distinct clusters and synchronized movements. The combined effects of cohesion and alignment result in visually stable and synchronized swarm behavior, surpassing the original swarm's dynamics.

Explanation and Expectation of Modifications

The original model simulates swarm behavior using three main principles: separation, cohesion, and alignment. Each boid adjusts its position and velocity based on the positions and velocities of nearby boids, aiming to achieve collective patterns. The model includes functions for separation, cohesion, alignment, and the main update function for boids. Modifications were introduced to enhance the model's realism and adaptability.

The first modification introduced an **Obstacle** class with attributes for position and radius. The Obstacle class contains **avoid_obstacles** function to calculate avoidance vector for each boid based on obstacles. We have modified the **update_boid_with_obstacles** function to include avoidance behavior. Finally, we added simulation run that showed boids adjusting paths to steer clear of obstacles, aligning with expectations. The expectation was that boids would exhibit avoidance behavior, altering their paths when encountering obstacles.

The second modification introduced **introduce_perturbations** function to add random perturbations to boid velocity. We have modified **update_boid_with_perturbations** to include random perturbations. Finally we added a simulation run with perturbations, where boids experience random disruptions to their velocities. We expected boids to show erratic movements and a disruption of cohesive patterns due to random perturbations.

Observations and Comparison of Modifications

In the simulation with obstacles, the swarm effectively avoids obstacles, showcasing a coordinated and synchronized movement. This behavior aligns with practical applications, such as drone swarms navigating cluttered spaces, where obstacle avoidance is crucial. The addition of this feature contributes positively to swarm coordination. The avoidance behavior was successfully observed, aligning with expectations.

On the other hand, the simulation with perturbations results in less cohesive movement. Boids deviate from a synchronized pattern due to the introduced randomness in their velocities. This introduces a level of unpredictability, reflecting scenarios with inherent environmental uncertainties. Boids displayed more chaotic movements, consistent with expectations of random perturbations disrupting cohesive patterns. While perturbations may mirror real-world scenarios, they also disrupt the structured and coordinated movement observed in the absence of external influences.

Comparatively, the choice between obstacle avoidance and perturbations depends on the specific requirements of the application. Obstacle avoidance is suitable for scenarios where structured navigation is crucial, contributing to swarm coordination. In contrast, random perturbations introduce a more unpredictable element, reflecting scenarios with inherent environmental uncertainties. Ultimately, these modifications offer insights into different facets of swarm behavior, providing flexibility for tailoring simulations based on specific application needs.