Flocking

Simulating groups with Steering Behaviours

Steering Behaviour Recap

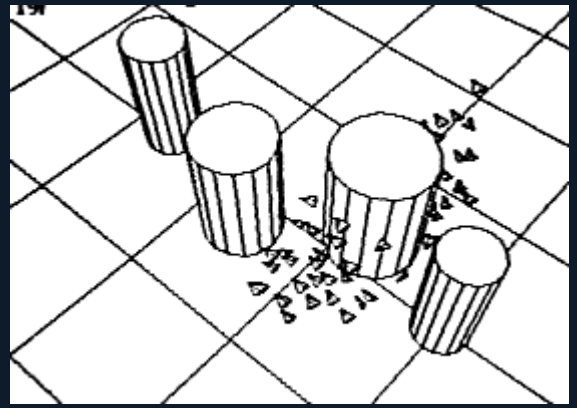
- Steering Behaviour are a way to add locomotion of autonomous agents
  - They calculate a force to apply to an agent's velocity to steer them in a certain direction

- Each of the previously discussed steering behaviours focused on individual agents acting alone
  - Steering behaviours can be extended to add natural-looking group motion to agents

Groups and Boids

- Group steering behaviours require an agent to know about other agents around it

- Craig Reynolds created a program for simulating bird-like and fish-like flocks and schools, using steering behaviours, in 1986
  - He called the agents in this technique “boids”, meaning “bird-like objects”
  - The technique was called “Flocking”



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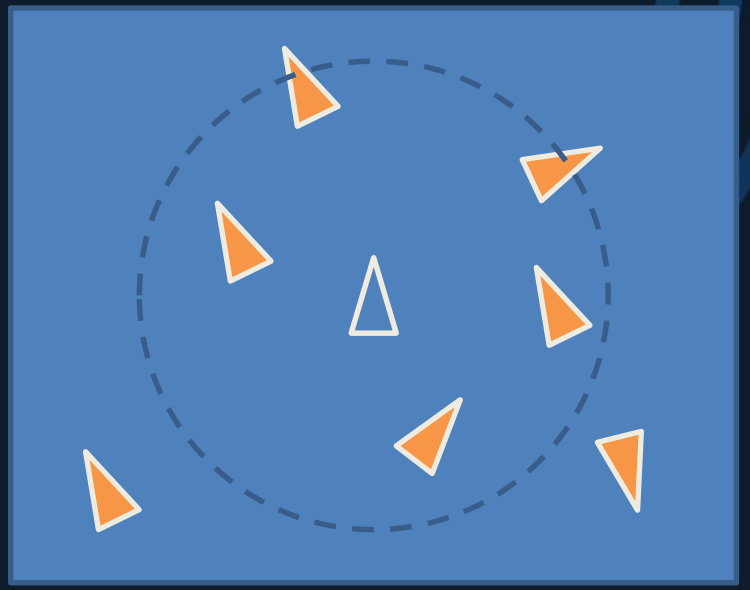
Flocking Behaviours

- Boids make use of 3 Steering Behaviours
  - Separation
  - Alignment
  - Cohesion

- Together these behaviours create very believable and realistic group motion for many things
  - Flocks of birds, schools of fish, swarms of insects
  - Even crowds of people

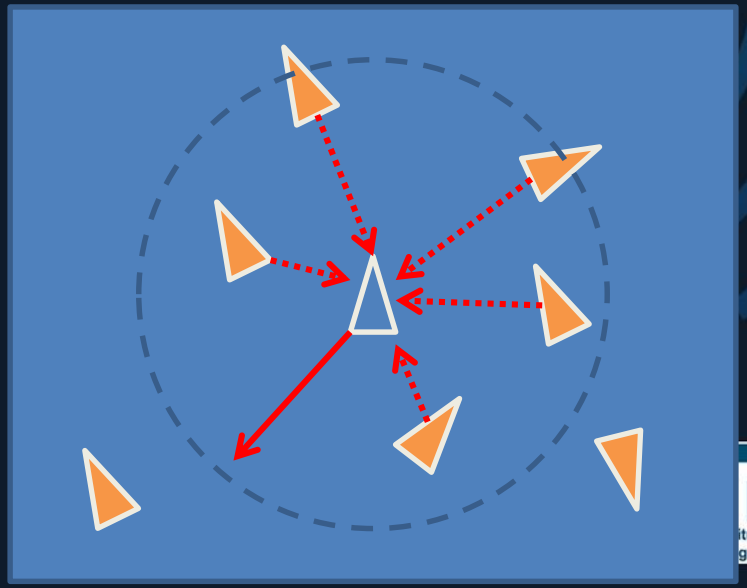
Boid Neighbourhood

- First our boids need a local neighbourhood of other boids near it to create a “flock”
  - Typically a neighbourhood radius around the boid is used
  - We could sample against all other boids in the scene, or use spatial partitioning to speed up the search
- The boids within this neighbourhood are used in the 3 steering behaviours for flocking



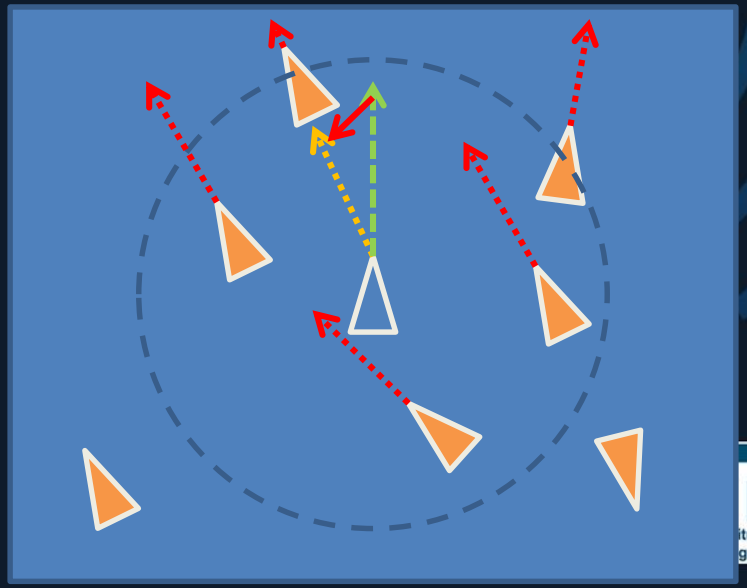
Separation

- Separation calculates a repulsion force away from all neighbouring boids and sums the forces together
  - A repulsion value is used to weight the forces, controlling the spacing
- Used to keep a flock spaced apart
  - By itself this would cause all boids to move as far away from each other as possible



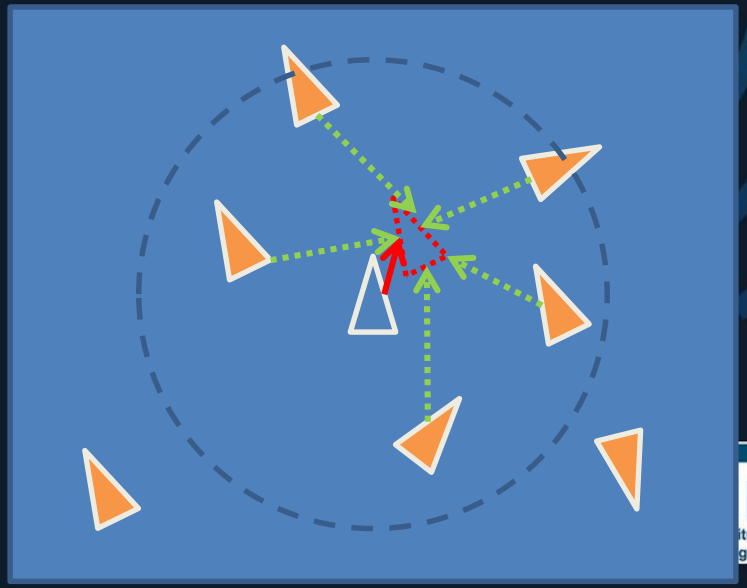
Alignment

- Alignment is used to steer the flock in the same direction
- The average velocity of all neighbouring boids is calculated as a “desired” velocity
  - The alignment force is then the difference between the desired and the boid’s current velocity



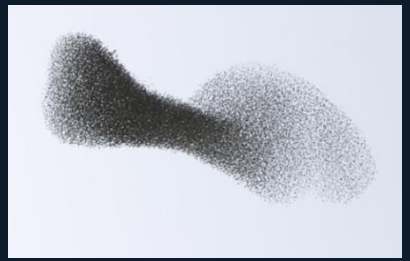
Cohesion

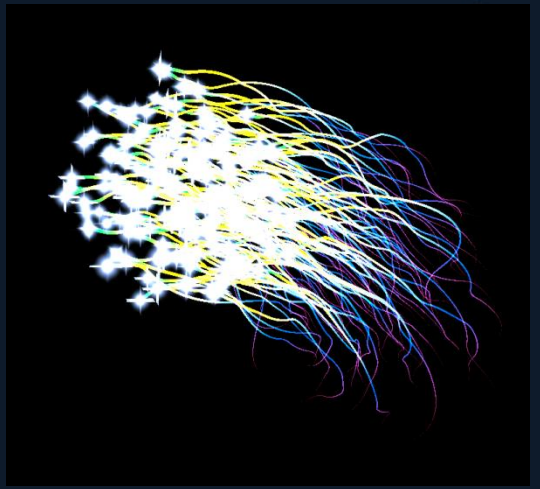
- Cohesion is what makes the flock stay together
  - Acts against separation
- The average position of neighbouring boids is calculated
  - The boid then simply Seeks towards this target



Combining the Behaviours

- Combing the force from all three behaviours gives us the flocking behaviour
  - We can use **Weighted Truncated Running Sum with Priority** to combine the behaviours, or simply sum the forces to act as a single force





- The result gives us interesting flocking and swarming behaviours

Modified Flocking

- Flocking is typically combined with other steering behaviours
  - Obstacle avoidance means the flock can move around walls and obstacles while still maintaining the flock
  - Wandering adds an extra bit of randomised motion to the flock, easily representing boids leaving and joining other flocks

- A "**Leader**" can be added to the flock, whose values are weighted higher than others
  - For example, its alignment velocity could be increased so that other boids follow it

Summary

- Flocking is an extremely interesting and dynamic set of behaviours that can easily represent naturally occurring motion within flocks, swarms and schools
- Useful in games, film and simulation
- Easily combines with other steering behaviours