1 Boid Behavior

Each boid maintains a position vector, $\vec{p}$, and a velocity vector, $\vec{v}$. At each time step the boid calculates an acceleration vector,$\vec{a}$ based on local rules described below. The new velocity and positions vectors are calculated as:

$$\vec{v}_{t+1} = \vec{v}_t + \vec{a}_t \Delta t$$
$$\vec{p}_{t+1} = \vec{p}_t + \vec{v}_{t+1} \Delta t$$

Creating the acceleration vector The acceleration vector is calculated from three vectors:

1. the difference between the mean position of the boid's local neighbors (radius for local neighborhood is a parameter) and the boid's current position,
2. the difference between the mean velocity of the boid's local neighbors and the boid's current velocity, and,
3. a weighted sum of differences between close neighbors' positions (controlled by a difference radius parameter) and boid's current position as well as differences from stationary objects.

Vector 1 represents the desire to be in the middle of the flock, vector 2 represents the desire to fly in the same direction and vector 3 encodes obstacle avoidance. Each of these desires is given a user controlled weight and the acceleration vector is constructed using one of two allocation techniques. The length of acceleration vector is limited by a global constant.

mean allocation The three component vectors are weighted, summed, and rescaled to the maximum acceleration.

priority allocation The three component vectors are weighted, ranked and added to the acceleration vector in amounts that respect the maximum acceleration. Vector 3 is of highest priority so if after weighting its length exceeds the maximum acceleration it is rescaled and used as the acceleration. If the weighted highest priority vector does not exceed the maximum acceleration we add as much of the weighted second priority (vector 2) to the weighted highest priority vector as follows.

Let $\vec{x}$ be the weighted highest priority vector and $\vec{y}$ the weighted second priority vector. Set

$$\alpha = \frac{-2(\vec{x} \cdot \vec{y}) + \sqrt{(2\vec{x} \cdot \vec{y})^2 + 4(\vec{y} \cdot \vec{y})(m^2 - \vec{x} \cdot \vec{x})}}{2(\vec{y} \cdot \vec{y})}$$

where m is the maximum acceleration and the dot product has the usual definition: $\vec{x} \cdot \vec{y} = \langle x_1, x_2, x_3 \rangle \cdot \langle y_1, y_2, y_3 \rangle = x_1 y_1 + x_2 y_2 + x_3 y_3$.

If $\alpha > 1$ set the current acceleration vector to $\vec{z} = \vec{x} + \vec{y}$ and continue by adding in the maximum amount of the weighted third priority in the same fashion. If $\alpha \leq 1$ the acceleration is $\vec{z} = \vec{x} + \alpha\vec{y}$.