SYNC or Swim: A Particle Model of the Interactions within Fish Schools

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Current Parameters

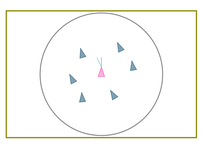
The current parameters of the model are as follows:

- **Number of Fish:** 2048
- **Weight of Alignment:**
- **Weight of Attractive Forces:**
- **Attraction Coefficient:**
- **Repulsion Coefficient:**
- **Target Attraction Coefficient:**
- **Sight Radius:**

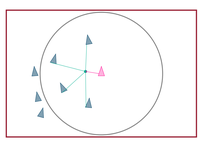
Schooling Model

Our model represents each fish adhering to the following three rules with respect to positioning relative to their peers in the school:

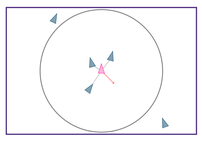
- **Alignment**
  Fish want to swim in the same direction as the other fish in their school.



- **Cohesion**
  Fish want to stay in the school.

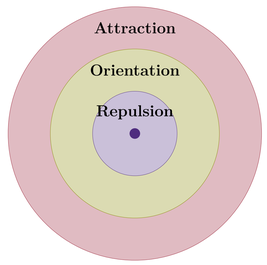


- **Separation**
  Fish don't want to collide with their neighbors.



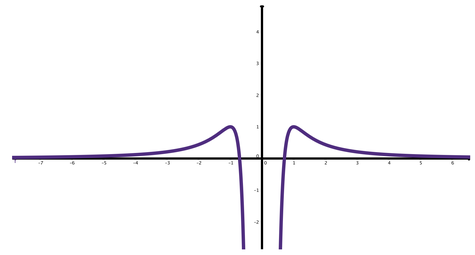
Metric Distance Model

Uses zones around fish to determine attractive, repulsive, and alignment forces on each fish. Although the figure below shows the zones with hard-defined boundaries, which does not happen in real life, but does illustrate the general idea of a metric distance model.



Ideal Distance

Using the force equation below, there are attraction and repulsive coefficients that we use to create an ideal distance between the fish.

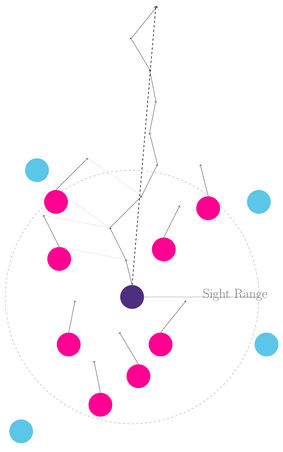


The ideal distance between fish occurs at _____, and the highest attraction is at _____.

Total Force on Each Fish from Neighboring Fish

$$F_{i_N} = \sum_{j=1}^{N} \left(W_A\left(C_A \frac{p_j - p_i}{d^2} - C_R \frac{p_j - p_i}{d^4}\right) + W_D\left(\frac{v_j}{||p_i - p_j||}\right)\right)$$

Directional Alignment



The direction of the focal fish is a weighted average of the direction of all of the fish within its sight range. The weight of the direction of each fish is determined by the distance to the focal fish.

Calculating Force, Velocity and Position

At every time step, the following calculations occur for each particle (let's call it particle i):

1. Calculate $||p_i - p_j||$ (distance between particle i and every other particle j).
2. If $||p_i - p_j||$ < our pre-determined sight radius, then use the total force on each fish from neighbors equation above to determine the force between particle i and particle j, and sum forces over all particles within the sight ardius of particle i.
3. Use F_{i_N} calculated above to update particle i's velocity as follows:

$$v_i = v_i + F_{i_N} \cdot dt$$

4. And finally update particle i's position using:

$$p_i = p_i + v_i \cdot dt$$

Motivation

Nunc tempus venenatis facilisis. **Curabitur suscipit** consequat eros non porttitor. Sed a massa dolor, id ornare enim. Fusce quis massa dictum tortor **tincidunt mattis**. Donec quam est, lobortis quis pretium at, laoreet scelerisque lacus. Nam quis odio enim, in molestie libero. Vivamus cursus mi at *nulla elementum sollicitudin*.

References

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