

# Optimal flocking of boids using a genetic algorithm

Frederik J. Mellbye

Stanford University

*frederme@stanford.edu*

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# Boids [Reynolds, 1987]

- Artificial Life program
- Used to simulate flocking
- Simple behavior rules



Figure: From <http://www.columbia-audubon.org/birds-in-big-numbers-flocks-of-blackbirds-and-starlings/>

# Boid rules

## Separation

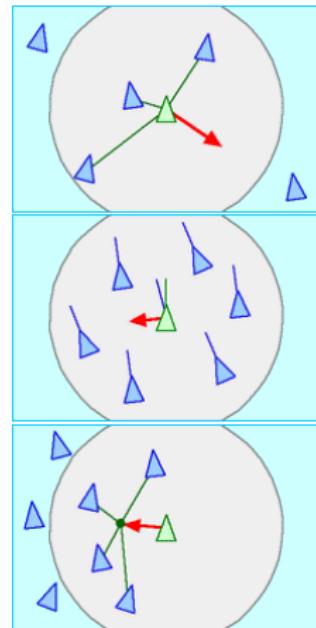
Boids steer away from each other when too close, to avoid crashing into each other.

## Alignment

Steer towards the average heading of local flockmates, aligning their directions.

## Cohesion

Steer towards the average position of local flockmates.

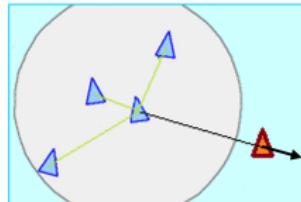


## Additions: Predators and boid removal

- Predators: chase nearest prey boid



- Prey boids are removed if a predator gets sufficiently close
- Predators flee if too many prey boids in close proximity



# Computing the force

- The force on a boid is a weighted sum of the steering forces:

$$\text{force} = c_1 \times \text{Separation} + c_2 \times \text{Alignment} + c_3 \times \text{Cohesion}$$

- Chromosome of  $i$ -th boid:

$$\mathbf{c}^{(i)} = [c_1 \quad c_2 \quad c_3]$$

# This project

- Goal: Find design (set of boid coefficients  $\mathbf{x} = \{c^{(i)}\}_{i=1}^N$ ) that minimizes the number of deceased prey boids.
- This will be done using a genetic algorithm. For each generation, real-valued crossover is performed on the survivors to form the next generation. Mutation is added in the form of  $\mathcal{N}(0, \sigma^2)$  noise.
- Hypothesis: Over many generations, the algorithm will find good parameters for flocking.

# Sample runs for different designs

See attached video in the repository.

# References



Reynolds, C. W. (1987)

Flocks, Herds, and Schools: A Distributed Behavioral Model, in Computer Graphics  
21(4) (*SIGGRAPH '87 Conference Proceedings*) pages 25-34.