Flocks, Herds, and Schools: A Distributed Behavioral Model

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Simulated Flocks Boids

- Simulate motion of flocks of birds or animals using individual behaviors
- Elaborates on a particle system
- More realistic than scripting the paths of the individual birds

Prior work

- *Eurythmy*
  - Flocking simulations used force-fields around each bird and around each object.
  - The animator sets the initial positions, headings, and velocities.

- Other behavioral control work by Karl Sims was based around groups of single objects, not flocks.

Particle Systems
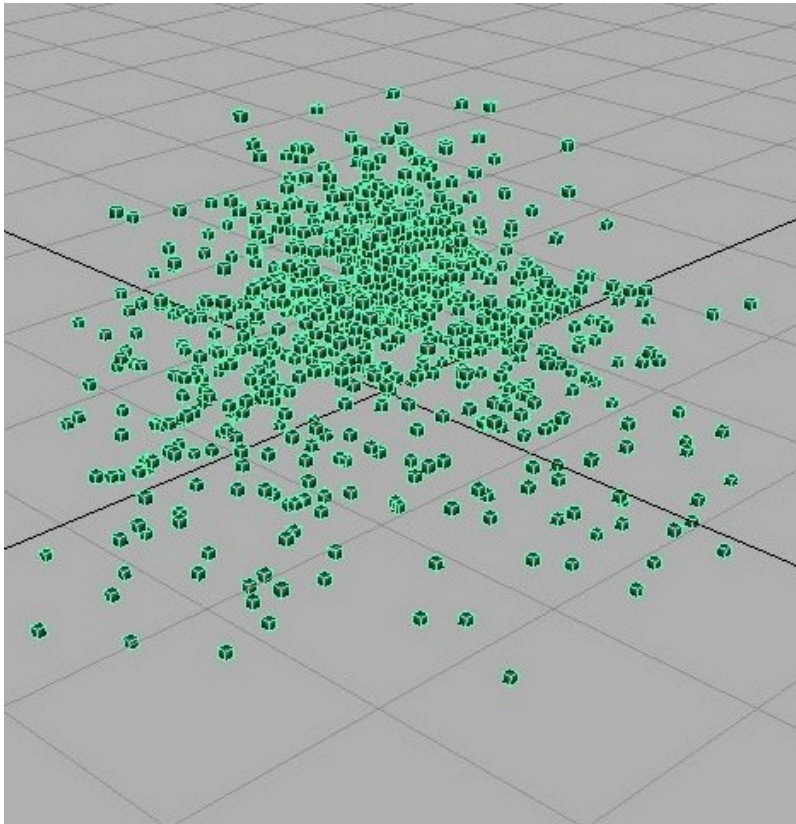
- Particle Systems are collections of large number of particles each with their own behaviors.
  - As of the time of the paper, they were used to model fire, smoke, clouds and ocean waves.

- Boid flock system is a generalization of a particle system

Geometric Model
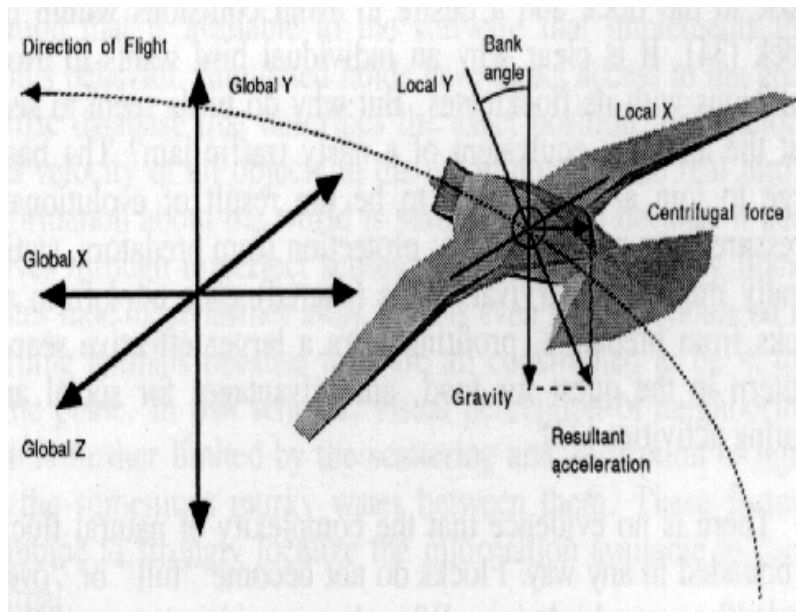
- Each boid uses an accurate geometric model for flight
  - Incremental translations along current path
  - Calculates each translation once per frame
    - Higher sampling rate refines the shape of motion.
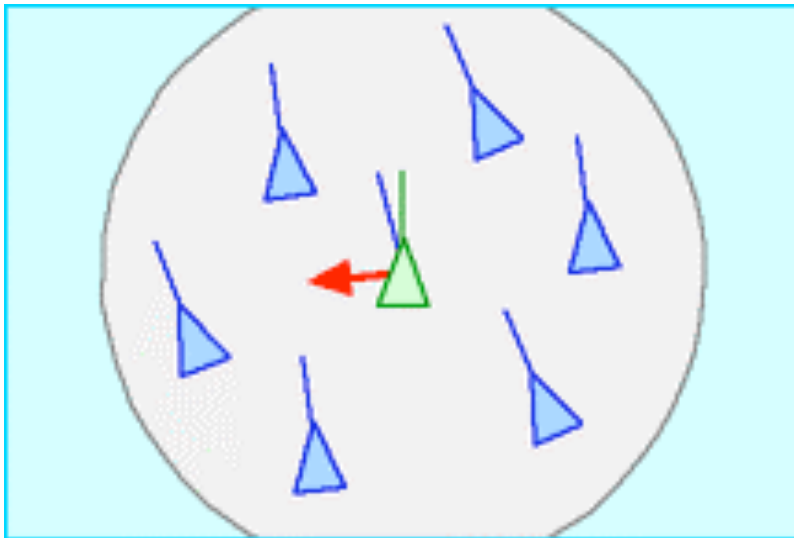
Simulated Flocks

- Create a boid model that supports geometric flight
- Add individual behaviors that oppose each other:
  - Separation
  - Alignment
  - Cohesion
  - Obstacle Avoidance
- The boids must be able to arbitrate conflicting behaviors as well.

Simulated Flocks: Separation
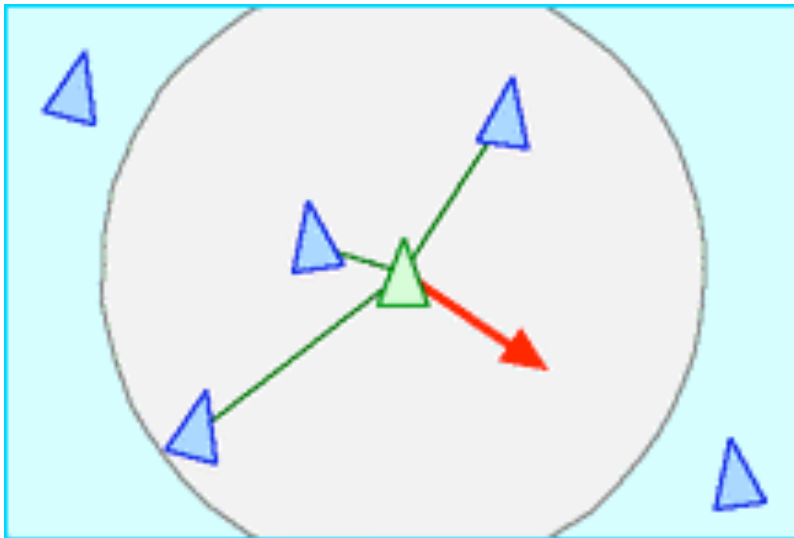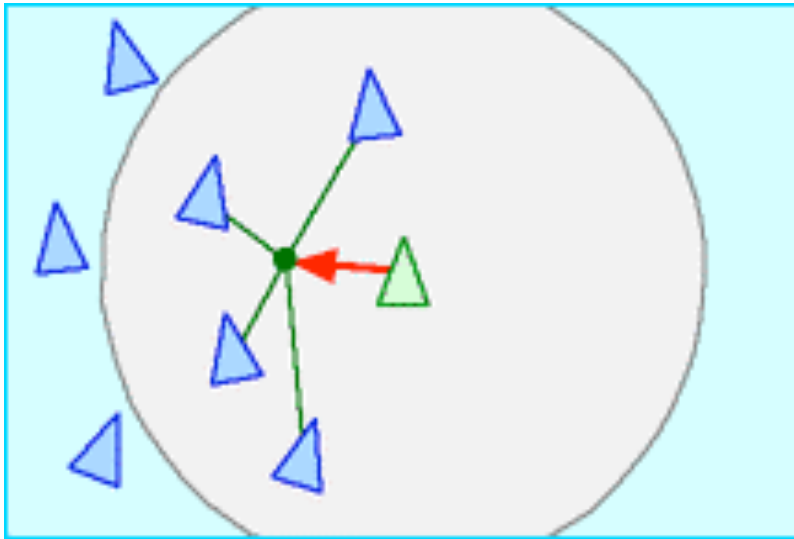

- Avoid crowding local boids

Simulated Flocks: Alignment

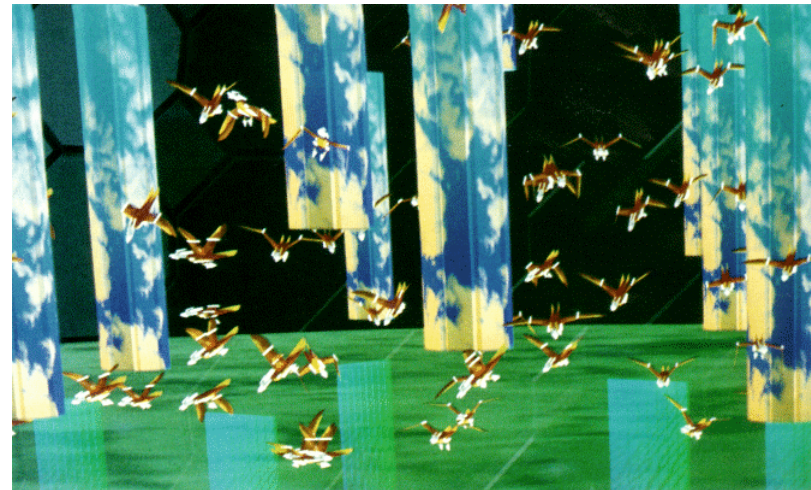- Steer toward the general heading of the rest of the flock
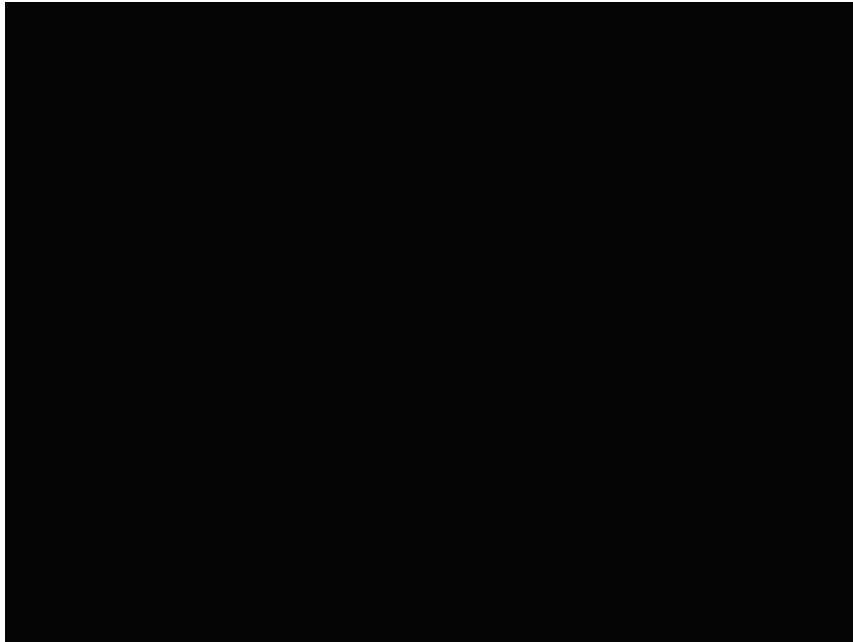
Simulated Flocks: Cohesion

- Move toward the average position of local flockmates.

Avoiding Obstacles

- Independently model the shape for rendering and collision avoidance.
- Boids model uses a *steer-to-avoid* as opposed to force-field concept.

Putting it all together

- Simulated Flocking behavior that mimics real life flocks and herds.

  - When combined with low priority goal seeking results in a scripted path of the flock.

Conclusion

- Boids is a model of non-colliding motion of flocks based on simulating behavior of individual boids.

- Boid model is an example of emergent behavior
  - Simple local rules lead to complex global behavior

- References
  - http://www.red3d.com/cwr/boids/
  - Paper: http://www.cs.toronto.edu/~dt/siggraph97-course/cwr87/