Boids

COS 426
Boids

• Overall idea
  ◦ Simulate group behavior by specifying rules for individual behavior (self-organizing distributed system)

“... and the thousands off fishes moved as a huge beast, piercing the water. They appeared united, inexorably bound to a common fate. How comes this unity?.. “
- Anonymous.
Boids

- Powerful, simple model
  - No central control
  - Only simple rules for each individual
  - Complex, emergent phenomena
  - Self-organization, swarm intelligence

Reynolds
Boids

• Computer graphics motivation
  ◦ Scripting of the path of many individual objects using traditional computer animation techniques is tedious.
Boids

• Like a particle system, except …
  ◦ Each boid may be an entire polygonal object with a local coordinate system (rather than a point)
Boids

- Like a particle system, except …
  - Each boid can “perceive” a local region around it, e.g., a spherical neighborhood

http://www.arges-systems.com
Boids

- Like a particle system, except …
  - Each boid exerts “intentional forces”
Flocking

- Complex flocking behaviors can be modeled with simple “intentional forces”
  - Separation
  - Alignment
  - Cohesion
Flocking – 3 Behaviors (1)

- Separation = collision avoidance: avoid collisions with nearby flockmates
Flocking – 3 Behaviors (2)

- Alignment = velocity matching: attempt to match velocity with nearby flockmates
Flocking – 3 Behaviors (3)

- Cohesion = flock centering: attempt to stay close to nearby flockmates

http://www.red3d.com
Other Examples (single behavior)

- Example behaviors
  - Seek
  - Flee
  - Evasion
  - Pursuit
  - Wander
  - Arrival
  - Obstacle Avoidance
  - Containment
  - Wall Following
  - Path Following
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Other Examples (combined behaviors)

- Combined behaviors
  - Queuing = seek, containment, & separation
  - Flocking = alignment, cohesion, & separation

- Seek
- Containment
- Separation
Obstacle Avoidance (1)

- **Force field approach**
  - Obstacles have a field of repulsion
  - Boids increasingly repulsed as they approach obstacle

- **Drawbacks:**
  - Approaching a force in exactly the opposite direction
  - Flying alongside a wall
Obstacle Avoidance (2)

- **Steer-to-avoid approach**
  - Boid only considers obstacles directly in front of it
  - Finds silhouette edge of obstacle closest to point of eventual impact
  - A vector is computed that will aim the boid at a point one body length beyond the silhouette edge

http://www.red3d.com
Arbitrating Independent Behaviors

- Navigation module of boid brain to collect relevant acceleration requests and then determine single behaviorally desired acceleration
  - Weighted average according to priority

- Emergency acceleration allocated to satisfy pressing needs first
  - Example: Centering ignored in order to maneuver around obstacles
Boids Example

Reynolds
Boids Example

boids

This is a lightweight 2D JavaScript implementation of Craig Reynolds' Boids algorithm. It's a classic example of emergence and a surprisingly simple way of mimicking not only flocks, but any form of swarm or herd or crowd.

Right now you're watching 477 boids being simulated at 60 frames per second.

Source on GitHub

http://hughsk.io/boids/
Boids Example

https://playcanv.as/b/RMmDJFwM/