Lecture 31 - Flocking

Monday, April 2, 2018 12:20 PM

Why do creatures flock?
- Defense against predators
- Flight efficiency
- Finding a mate
- Finding food as a group

Creatures have limited perception
- Flocks may be larger than the animals can perceive
- Creature decisions are then made using a subset of all creatures in the flock

Boid Behaviors
- Stay close to the flock
- Avoid collisions

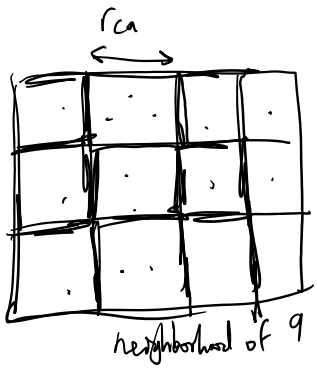
Boids
- Each boid has a state
  - Position (x, y, z)
  - Orientation / Speed
  - Velocity (x, y, z) (Orientation and speed)
- Velocity limits:
  - Minimum and maximum velocity

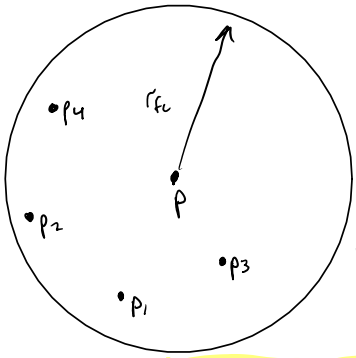
Flocking Behaviors
1. Collision avoidance
   - Avoid collision with other boids
2. Velocity matching
   - Match this boid's velocity with boids near it
3. Flock centering
   - Go near the other boids

Finding nearly flockmates (within radius r)
- Naïve method O(n^2)
- Using grids O(n)

Perception
- Vision
- Hearing
- Lateral lines (sense pressure)
- Just find nearby flockmates within a given radius

Avoiding Obstacles
- Steer-to-avoid
  a. Intersect forward ray with world
  b. Find silhouette point closest to the intersection
  c. Aim one body length away from the silhouette





$p = (p_x, p_y)$

$p_i = (p_x^i, p_y^i)$

list of K nearest neighbors within radius r_{fc}

unweighted centroid $C = \frac{1}{K}\sum_{i=1}^{K} p_i$

Unweighted does not account for distance of nearby boids

Flock centering force $f_c = C - p$

Unweighted case

$$f_c = \frac{\sum_{i=1}^{K} w_i (p_i - p)}{\sum_{i=1}^{K} w_i}$$

Distance between boids i + j:

$$d_{ij} = \sqrt{(p_x^i - p_x^j) + (p_y^i - p_y^j)}$$

Weight:

$$w_{ij} = \frac{1}{d_{ij}^2 + \varepsilon}$$

Collision Avoidance

Tighter radius r_{ca} (smaller than r_{fc})

$$f_{ca} = \sum_{i=1}^{K} w_i (p - p_i)$$

Velocity Matching

$r_{vm} \approx r_{fc}$

$$f_{vm} = \sum_{i=1}^{K} w_i (v_i - v)$$

Wander

$f_w = (r_x, r_y)$ random values in $[-1, 1]$

can use perlin noise

Sum of all forces

$$f_{all} = w_{fc} f_{fc} + w_{vm} f_{vm} + w_{ca} f_{ca} + w_w f_w$$

adjustable weights