

Boids!

Hawk Weisman and Willem Yarbrough

Department of Computer Science
Allegheny College

April 27, 2015

What are Boids?

- ▶ An artificial life simulation [1, 3]
- ▶ 'Bird-oid' flocking behaviour [1, 3]
- ▶ first described by Craig Reynolds in 1987 [3]

Why Boids?

- ▶ Some major appearances:
 - ▶ *Half-Life* (1998)
 - ▶ *Batman Returns* (1992)
- ▶ Other applications:
 - ▶ Swarm optimization
 - ▶ Unmanned vehicle guidance

Our Implementation

- ▶ **Haskell** programming language:
 - ▶ It's good [2]
 - ▶ Will should explain this; it's his pet toy language

What is a Boid?

- ▶ Consists of
 - ▶ A position p_i
 - ▶ A velocity vector \vec{v}_i
 - ▶ A sight radius r
- ▶ In Haskell:

```
type Vector = V2 Float
```

```
type Point  = V2 Float
```

```
type Radius = Float
```

```
data Boid = Boid { position :: !Point  
                  , velocity :: !Vector  
                  , radius   :: !Radius  
                  }
```

```
deriving (Show)
```

Separation steering vector

- Tendency to avoid collisions with other boids

$$\vec{s}_i = - \sum_{\forall b_j \in V_i} (p_i - p_j)$$

- In Haskell:

```
separation :: Boid -> Perception -> Vector
separation self neighbors =
  let p = position self
  in negated $
    sumV $ map (^-^ p) $ positions neighbors
```

Cohesion steering vector

- ▶ Tendency to steer towards the centre of visible boids
- ▶ Calculated in two steps:

$$c_i = \sum_{\forall b_j \in V_i} \frac{p_j}{m} \quad (1)$$

$$\vec{k}_i = c_i - p_i \quad (2)$$

- ▶ In Haskell:

```
centre :: Perception -> Vector
centre boids =
    let m = fromIntegral $ length boids :: Float
    in sumV (positions boids) ^/ m
cohesion :: Boid -> Perception -> Vector
cohesion self neighbors =
    let p = position self
    in centre neighbors ^-^ p
```

Alignment steering vector

- Tendency to match velocity with visible boids

$$\vec{m}_i = \sum_{\forall b_j \in V_i} \frac{\vec{v}_j}{m}$$

- In Haskell:

```
alignment :: Boid -> Perception -> Vector
alignment _ [] = V2 0 0
alignment _ neighbors =
    let m = fromIntegral $ length neighbors :: Float
    in (sumV $ map velocity neighbors) ^/ m
```


References



Christopher Hartman and Bedrich Benes.

Autonomous boids.

Computer Animation and Virtual Worlds, 17(3-4):199–206, 2006.



Paul Hudak and Mark P Jones.

Haskell vs. Ada vs. C++ vs. awk vs.... an experiment in software prototyping productivity.

Contract, 14(92-C):0153, 1994.



Craig W Reynolds.

Flocks, herds and schools: A distributed behavioral model.

ACM Siggraph Computer Graphics, 21(4):25–34, 1987.