Boids!

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What are Boids?

- An artificial life simulation
- 'Bird-oid' flocking behaviour
- first described by Craig Reynolds in 1987 [**?**]

Why Boids?

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

What is a Boid?

- Consists of
    - A position p_i
    - A velocity vector $\vec{v_i}$
    - A sight radius r
- In Haskell:

```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:

```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:

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

$$\vec{k_i} = c_i - p_i \qquad (2)$$

- In Haskell:

```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

$$\vec{m}_i = \sum_{\forall b_j \in V_i} \frac{\vec{v}_j}{m} \qquad (3)$$

- In Haskell:

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