Computer Animation

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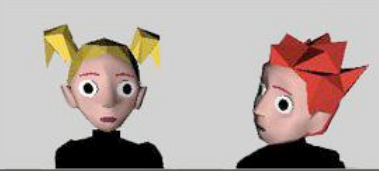
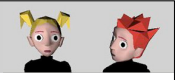
Heavily based on slides by Marco Gillies





Behaviour Simulation

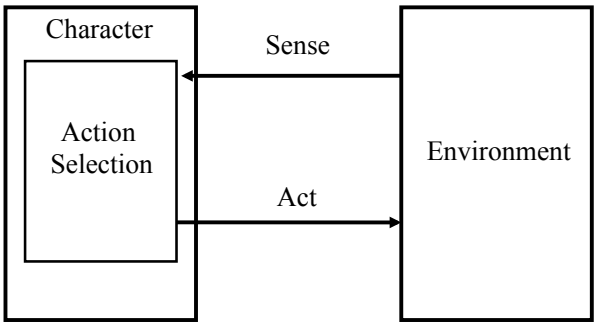
Behaviour simulation

- Have a procedural model of a character's behaviour that decides what the character should do next
- A lot of overlap with AI

Behaviour simulation

- Sense - Action selection – Act
- Flocking and crowds

Simulating behaviour



Sense-Select-Act

- The "Agent" paradigm
- Comes from AI
- The character is
  - Autonomous
  - Reactive
  - Proactive

Sensing

- To act the character needs to know about the environment
- In a graphical world this is easy, you have everything stored in the scene graph!
- Need some sort of filtering rule to make sure that a character doesn't know stuff it shouldn't (e.g. see stuff behind it)

Action Selection

- Decide what to do next depending on what the character has sensed and its current state
  - (if the character has no state then the behaviour is called "reactive")
- This is the core of the behaviour simulation
- Can be done based on a number of factors

Action Selection

- Satisfying drives
  - Hunger, tiredness, social (e.g. The Sims)
- Path finding
  - Getting around an environment
- Emotion
  - Expressing emotion
  - Influencing actions
- Goals
  - Does actions which help achieve goals

Act

- Implement the action
- Turn the action specification into a piece of animation of the type we've talked about
- Need motion specific to the action (which isn't known in advance)
- 2 ways of doing it
  - Inverse Kinematics
  - Motion capture/hand animated

Act: IK

- If an action involves:
  - Interacting with an object
  - Moving the hand to a particular location
  - Moving the hands to a particular place on the body (e.g. hands on hips)
- Inverse Kinematics is an obvious choice

Act: IK

- Pros
  - Allows exact placement of the hands (or other body parts)
  - Very flexible, allows a large range of actions
- Cons
  - Not as good quality motion as mocap or hand animated
  - expensive

Act: Canned Motion

- To get higher quality motion you need to use canned motion
- Either motion captured or hand animated

Act: Canned Motion

- Pros
  - High quality motion
  - Faster
- Cons
  - Limited range of motions
  - Either limits to a small number of actions
  - Or you end up using inappropriate motion

Act: Motion reuse

- The best of both worlds would be to have a way of changing motion to fit the current situation without reducing its quality
- There are many methods to do this (though the quality often suffers a bit)

Act: Motion reuse

- One way is to combine motions
- E.g. if you want to walk, turning left by 20° and you have a straight walk and a 45° walk
- Blend the two walks together (linear interpolation
- Turn20 = slerp(straight, turn45, 20/45)

Act: Motion reuse

- Motions can be composed out of smaller sub motions
- E.g. gestures can be composed out of small sub-gestures
- Apply different sub-motions to different joints
- Or blend as before

Act: Motion reuse

- Apply one motion “on top of” another
- E.g. if you have a motion (walking) you can apply a posture to it (hunched over)
- Want to have all of both motions (not blending or separate joints)
- Quaternion multiplication will combine the effects

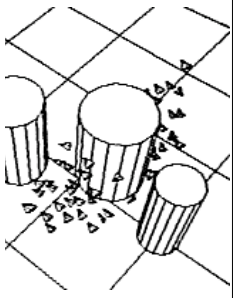
$$q = q_1 q_2$$

Act: Motion reuse

- So we have 3 simple methods
  - Blend 2 motions (interpolate)
  - Apply different motions to different joints
  - Quaternion multiplication
- Also more complex methods
  - Combining IK with canned motion
  - Find IK solution that is closest to the motion

Craig Reynolds - flocking

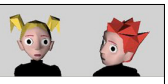
- The first behavioural simulation
- Simulates the behaviour of flocks of birds (boids), schools of fish or herds of animals
- Extensively used in films and other applications
- "Flocks, herds and schools: a distributed behavioural model" Craig Reynolds SIGGRAPH 1987



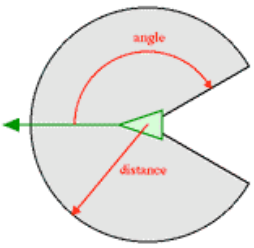
Boids: Sensing

- The boids have direct access to the scene graph
- They directly sense aspects of the behaviour of other boids in their flock
- They also "see" a simplified representation of objects that can act as obstacles

Boids: Sensing



- Need some filtering to provide realistic sensing
- (and reduce computation)
- Only sense other boids within a certain distance and angle



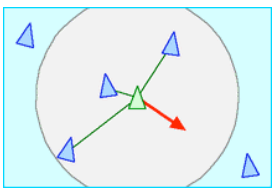
Reynold's 87

Boids: Action Selection

- Craig Reynold's work was an early aspect of the artificial life field
- He observed the behaviour of real flocks of birds and tried to figure out rules of their behaviour
- The resulting rules are surprisingly simple

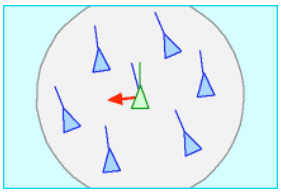
Boids: Action Selection

- Separation
- Steer away from flockmates that are very close



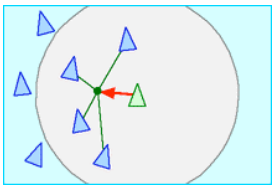
Boids: Action Selection

- Alignment:
- Match direction to the average direction of nearby flockmates



Boids: Action Selection

- Cohesion:
- Move towards the centre of mass of nearby flockmates



Boids: Action Selection

- There is also a rule to avoid bumping into obstacles
- Obstacle Avoidance:
- Steer to avoid any obstacles in the scene

Boids: Action Selection

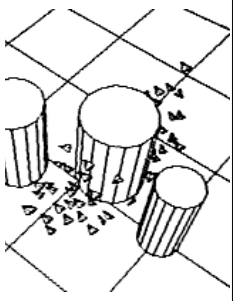
- The behaviours take strict priority over each other:
- Obstacle Avoidance
- Separation
- Alignment
- Cohesion

Boids: Act

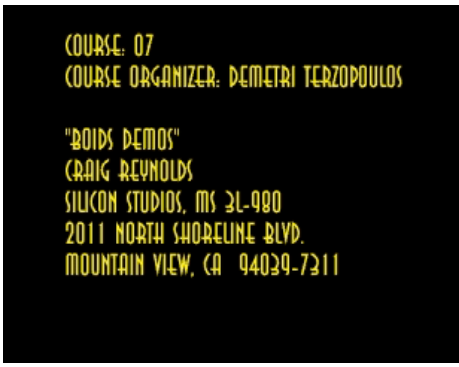
- boids are very simple they have a position, orientation and velocity
- They are moved by changing the velocity
- Animations can be added on top

Craig Reynolds - flocking

- Emergent Behaviour
- These simple rules produce surprising results
- Here is a flock splitting to avoid an obstacle
- They recombine afterwards, just like a real flock



Boids: Movie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