Computer Animation

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March 2013

Lecture slides based on previous versions produced by Marco Gillies

Outline

- Motion Editing
- Behaviour Animation
  - Primitive Behaviour
  - Intelligent Behaviour

Motion Editing

- Motion Retargeting
  - adapting one animated motion from one character to another
- Motion Combining
  - assembling motion segments into longer actions
- Styles Translation
  - transforming an input motion into a new style while preserving its original content

Motion Editing - Retargeting

- Adapting an animated motion from one character to another
- Here we only discuss when the target figure is identical to the original figure but with different segment lengths: for instance, different size of limbs
- This seems easy as skeletal animation animates rotations

Motion Editing - Retargeting

- Problems with motion retargeting
  - Foot not on floor
  - Self-penetration
  - Interaction with another avatar (video)

Gleicher 1998

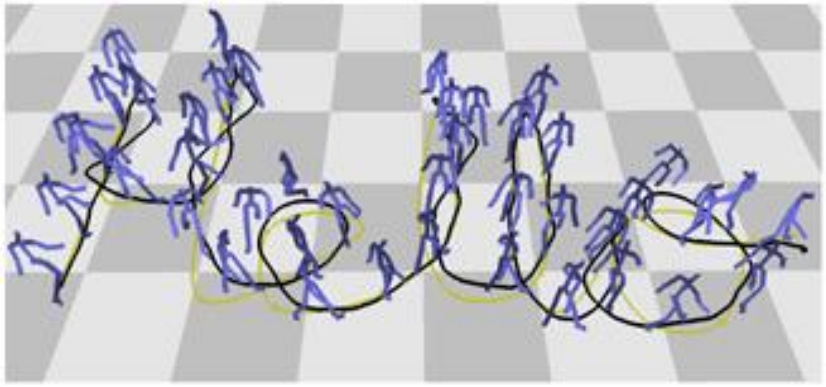
Motion Combining

- Generating a longer piece of motion from small motion segments
- Produce real time responses (useful in games)

Motion Combining

- Easiest: record all your motion with a neutral posture at the beginning and the end
- Motion blending
  - Blending the end of one segment into the beginning of the next segment (similar to key frame animation)
  - Transitions may look awkward unless the two blending points are similar

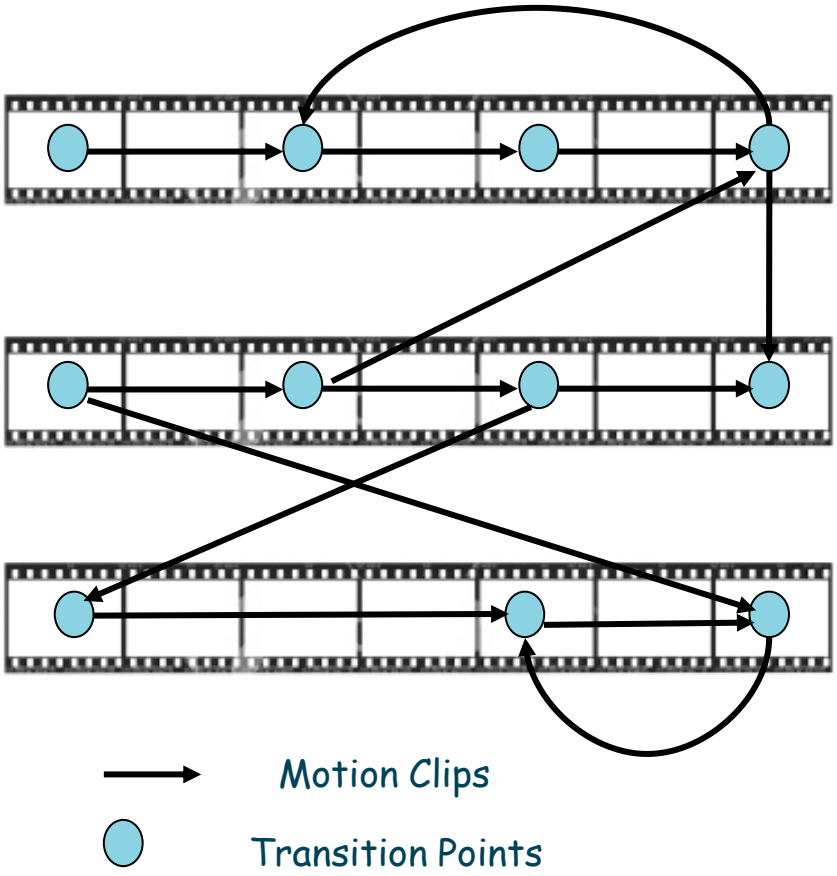
Motion Combining



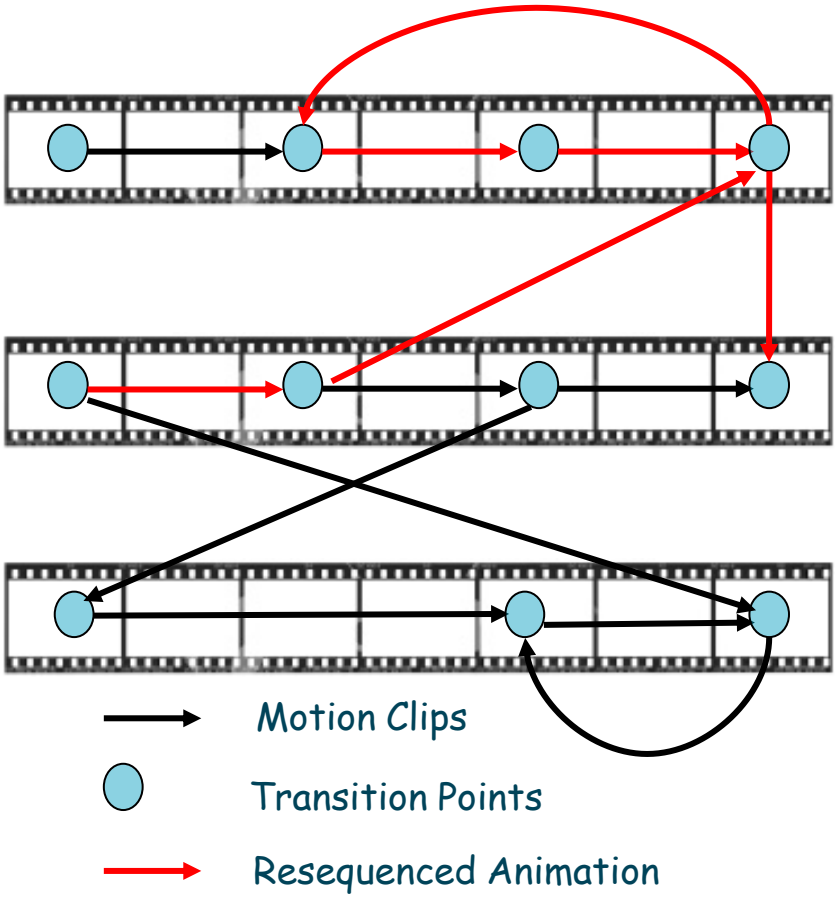
- Motion Graphs
  - Identifying good transitions between segments in a motion data base
  - Given a corpus of motion capture data (usually short clips), automatically construct a directed graph connecting the different motions and the transitions.

Kovar 2002

Motion Combing: Motion Graphs



Motion Combining: Motion Graphs



Motion Editing – Style and Content

- A motion can be separated into a Content component and a Style component
  - Content: walking, sitting down, jumping
  - Style: angry, masculine, proud
- Attempt to separate style and content
  - change style of a motion
  - apply style of one motion to another

Motion Editing – Style and Content

- Style translation: transforming an input motion into a new style while preserving its original content.
- An example:

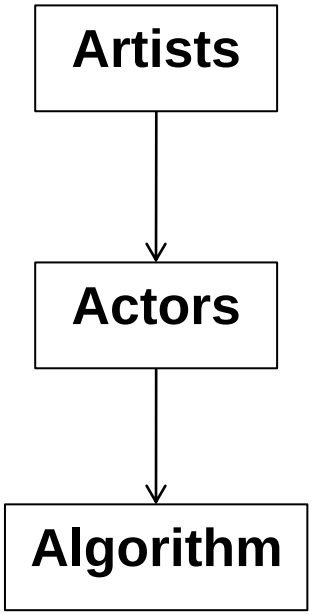
  videos\Style Translation for Human Motion.mp4

Hsu 2005

Computer Animation: Categorises

Three approaches to motion control:

- Artistic animation
  - Hand Animation (traditional animation)
  - Key frame and interpolation
- Data-driven animation
  - Motion capture
- Procedure animation
  - Simulations, artificial lives
  - Intelligent behaviour, AI



Behaviour Animation

Modelling Behaviour

- At the highest level of abstraction, the animator becomes the director
- The intelligent characters know how to get the job done
- The “director” only need to tell them what to do
- The intelligent characters produce realistic (or at least believable) performances.
- The characters appear to be *autonomous*
- They are called “actors” or “intelligent agent”

Modelling Behaviour

- Three Steps
  - Sensing: Knowing the environment
  - Action Selection: Decide what to do
  - Act: implement the action

Sensing

- Knowing the environment
- Low level
  - a character has direct access to the environment database (can “see” through walls)
- Medium level
  - modelling vision, so the character doesn’t see what he is not able to see
- High Level
  - modelling memory, so the character also remembers what he sees

Action Selection

- Decide what to do next depending on input (sensing) and its internal state
  - Overlap with AI
  - Core of behavioural simulation
- Possible factors
  - Satisfying drives (hunger, tiredness, social)
  - Path finding (getting around an environment)
  - Goals (which action helps achieve goals?)
  - Emotion, personality

Act

- Implement the action
- Methods:
  - Inverse Kinematics
  - Motion Capture/Hand Animation
  - Motion Editing

Act: IK

- Use IK when:
  - Interacting with an object
  - Moving the hand to a particular location
  - Moving the hands to a particular place on the body (hands on hips)
- Pros
  - Allows exact placement of the hand (or other body parts)
  - Very flexible, allows a large range of actions
- Cons
  - Less realistic
  - Expensive (difficult to generate real time)

Act: Motion Capture/Hand Animation

- 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 Editing

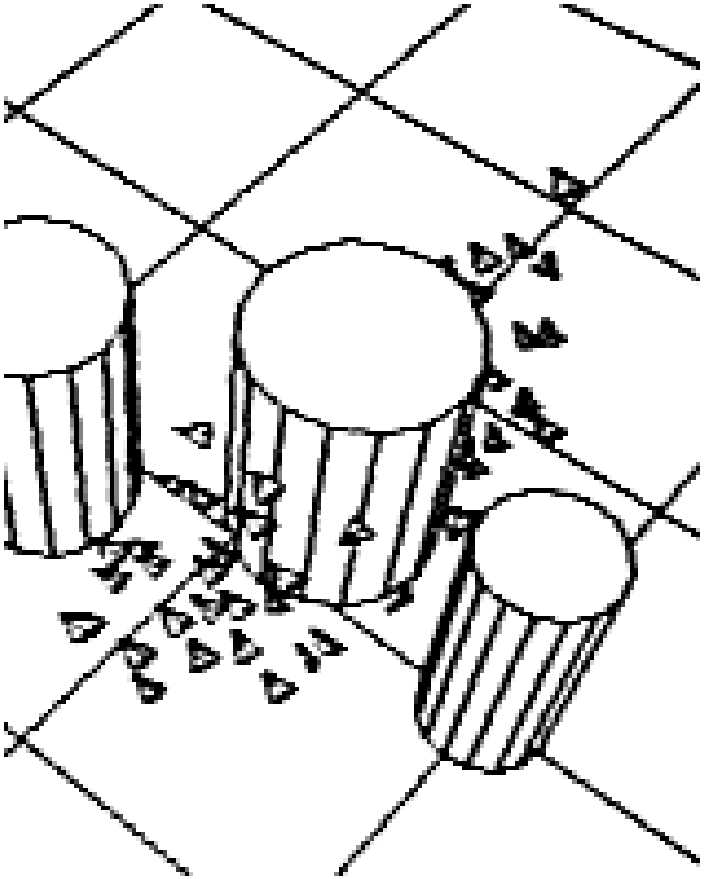
- Combine small motion segmentations together to produce target animation (blending)
- Apply different rotation to different joints (Masking)

Examples

- **Primitive behaviour: Flocking**
- Intelligent behaviour

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



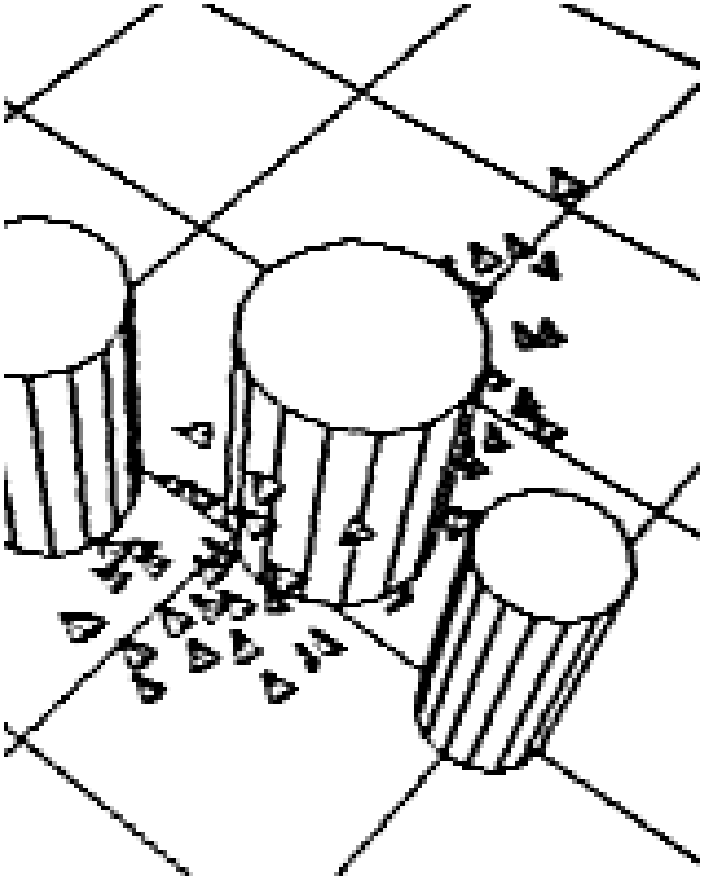
Reynolds 1987

Craig Reynolds - flocking

- 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

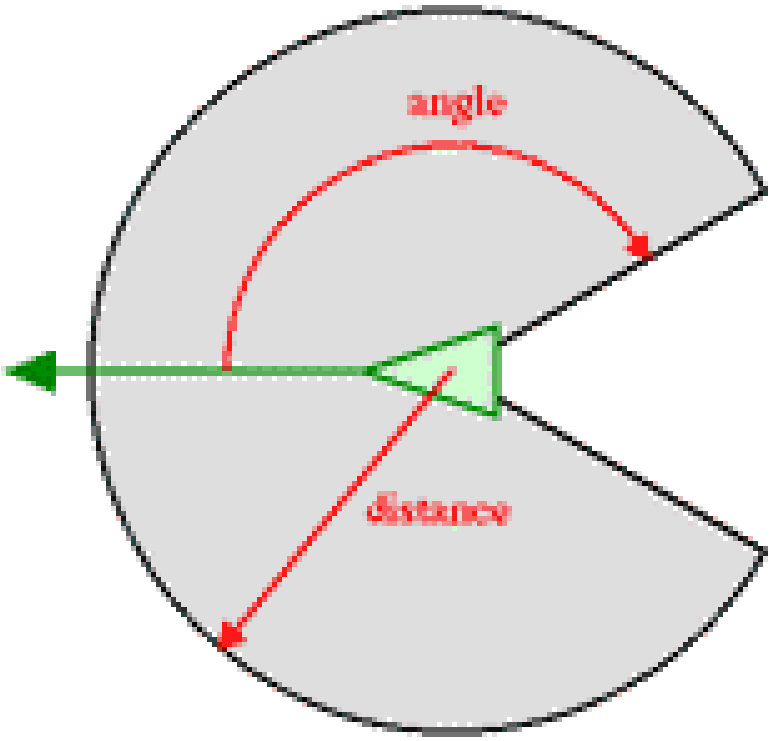
Boids: Sensing

- 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

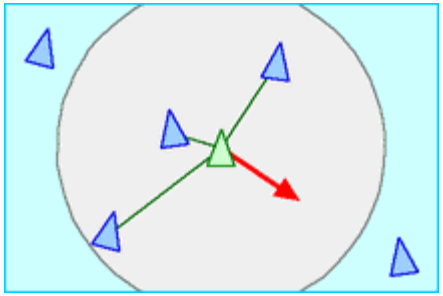
- Need some filtering to provide realistic sensing (and reduce computation)
- Only sense other boids within a certain distance and angle

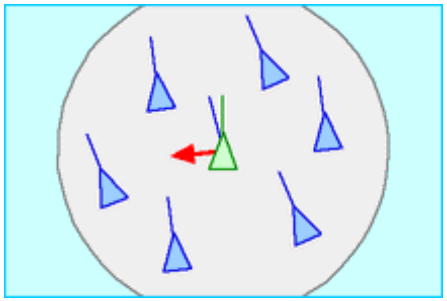


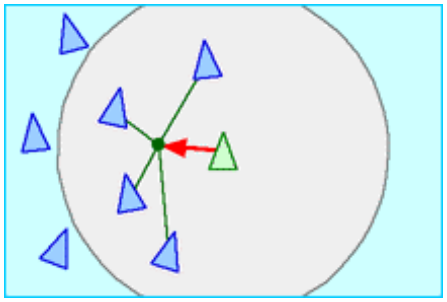
Reynolds 1987

Boids: Action Selection

- Obstacle Avoidance
- Separation
- Alignment
- Cohesion





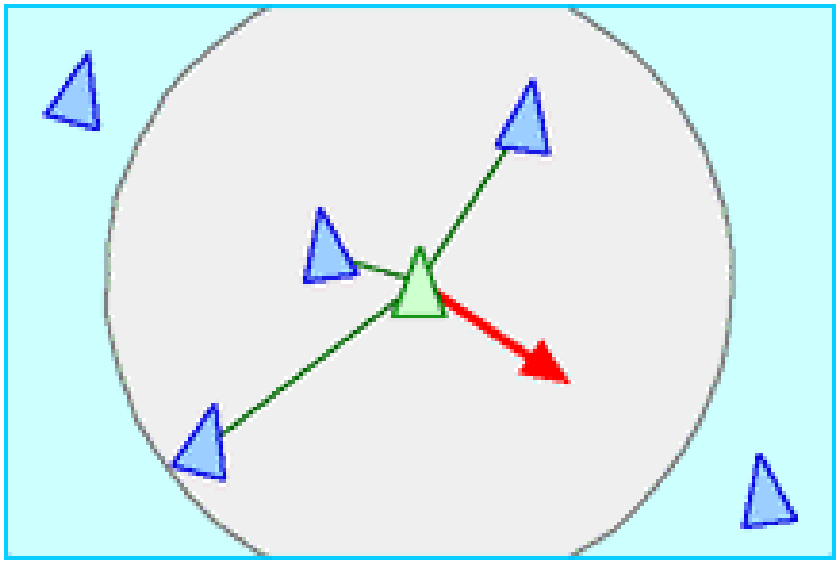


Boids: Action Selection

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

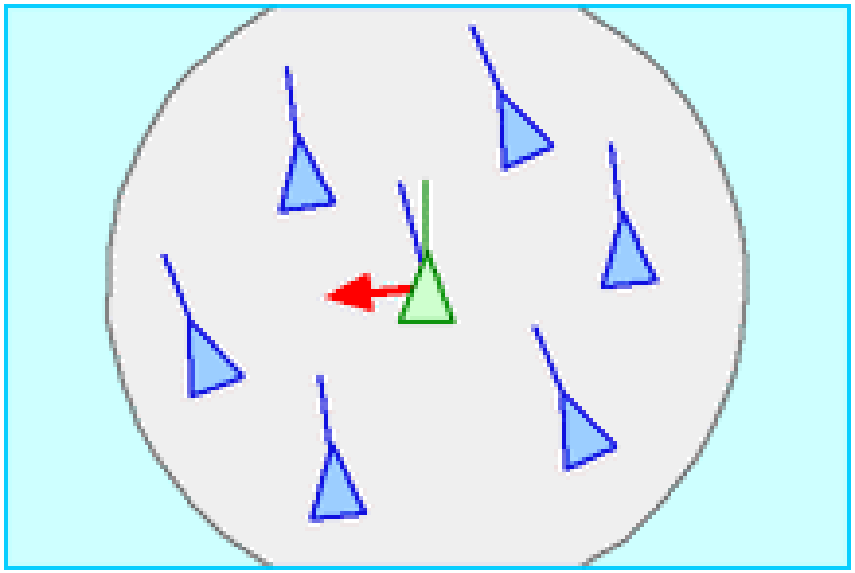
Boids: Action Selection

- Separation
  - Steer away from flockmates that are very close



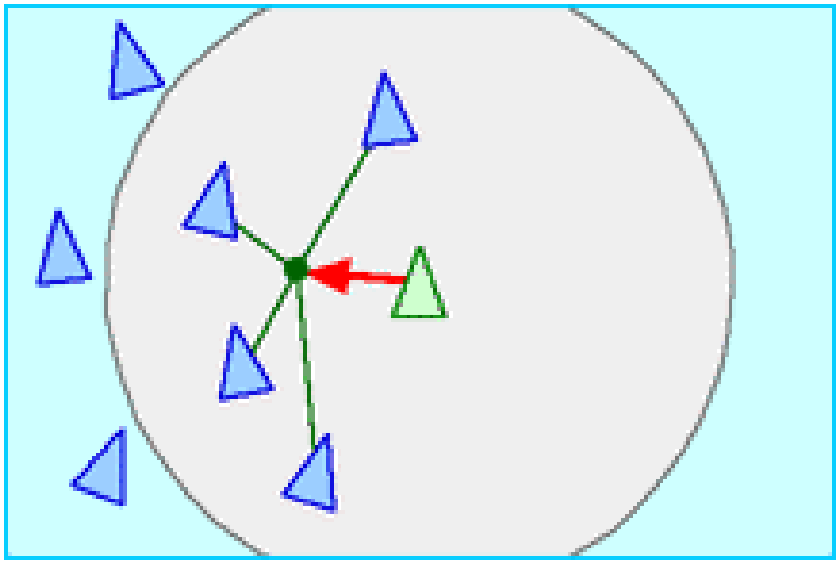
Boids: Action Selection

- 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

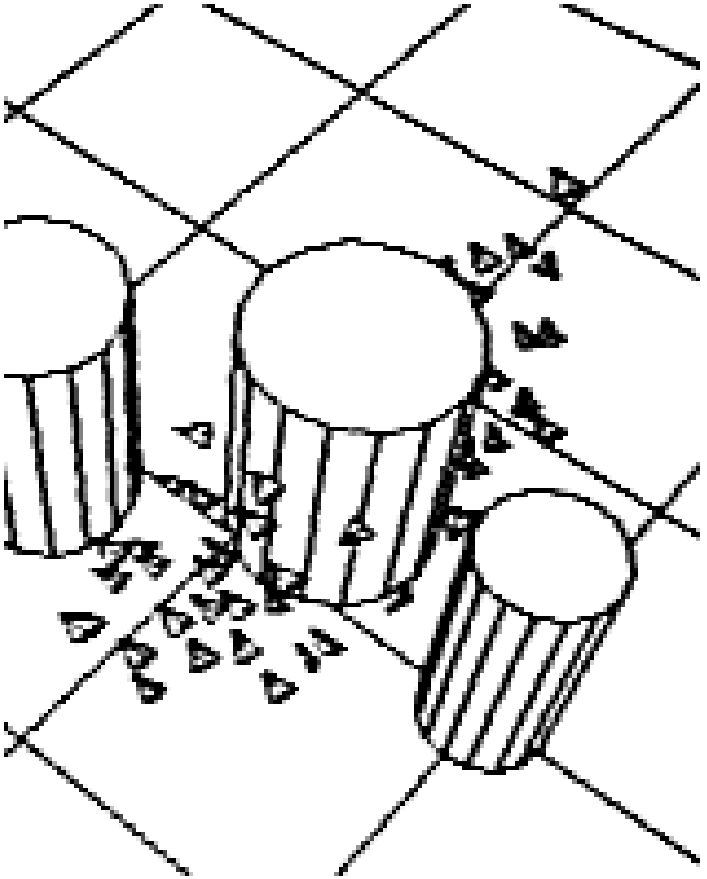
- The behaviours take strict priority over each other:
  - Obstacle Avoidance
  - Separation
  - Alignment
  - Cohesion

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
- videos\3cr.mov



Reynolds 1987

Examples

- Primitive behaviour: Flocking
- **Intelligent behaviour**

Modelling Intelligent Behaviour

- Many factor influence human behaviour:
  - Long term: personality, relationship
  - Short term: goal, mood, emotion
- Modelling realistic intelligent behaviour is still a research topic
- We don’t understand human behaviours fully!
- But if anything goes wrong, we can tell immediately!

Modelling Intelligent Behaviour

- How to implement?
- Depends on the application!

Facial Expression

- Functions of Facial expressions
  - Reflection of mental states and emotions produce typical facial patterns
    - Six basic emotions: happy, surprise, fear, angry, disgust, sad
  - Function of Communicative Acts
    - Complex mental states: agreement, disagreement, concentration, interest

Ekman 1969

Pan 2008

Body movement

- Although not as closely observed as the face, body movements also play an important role in interpersonal communication
  - Locomotion: navigate through scene
  - Posture and gesture: important communicative cues. Could reflect personality and emotions (e.g., extraverted or introverted)

Interacting with a Shy/Confident Avatar

- videos\ShyAvatar.wmv

Pan and Slater 2009

Commercial agents

- Microsoft Clippy
- Ikea Anna
  - http://www.ikea.com/gb/en/
- Cantoche
  - http://www.cantoche.com/en~Demo.html

The SEMAINE Project

- The Semaine project aims to build a Sensitive Artificial Listener (SAL), a multimodal dialogue system which can
  - interact with humans with a virtual character
  - sustain an interaction with a user for some time
  - react appropriately to the user's non-verbal behaviour

videos\Chatting with a virtual agent the SEMAINE project character Poppy.flv

videos\Chatting with a Virtual Agent The SEMAINE Project Character Obadiah 2.mp4

videos\Chatting with a Virtual Agent The SEMAINE Project Character Obadiah.mp4

videos\Chatting with a Virtual Agent The SEMAINE Project Character Spike.mp4