Motivation

- Okay, so you are in control
  - What about NPCs?

- Use AI to make your experience:
  - More compelling
  - More challenging

- Much AI is AS
  - Movement too simplistic
  - Movement too predictable
  - Movement too repeatable
Sample Uses of AI in Games

- Bad guys guarding something
- Bad guys looking for you
- Bad guys trying to beat you to something
- Bad guys trying to beat you (literally)
- Good guys working with you
- Other people just minding their own business
- Summary: 4 Bad, 1 Good, 1 Neutral

More Detailed Examples

- Bad guys
  - Find a path through the environment from where they are to where you are
  - Pac man ghosts
  - Guard the base, but if I see you, then attack!
  - Opponents racing around a track
    - Be fast, but block you too

- Good guys
  - If we are attacked, then counter!

- Neutral
  - Act natural, please!
Let's Start Small

- Objects in an environment follow rules
  - Physical laws
  - Damage
  - Fatigue
- Particles
  - Water flows
  - Fire burns, rises, heat dissipates
  - These are just rules!
- Higher-order beings also follow rules
  - They are just more complex

Basic Model of Particle Systems

- A collection of many minute particles
- For each frame:
  - New particles are generated, and assigned a set of properties
  - Old particles die, and are removed
  - Remaining particles change their properties, e.g., position, shape, color
  - Objects are rendered based on this new state
- Creation and attribute manipulation are procedural
  - Can be the result of computations
Changing Particle Properties

- How should the properties of the particles change over time?
  - Where does each particle move to?
  - How does its color change?

- Can be based on anything
  - Look at neighboring particles
  - Look at scene objects, like obstacles
  - Look at time
  - Look at distance traveled
  - Look at anything you want!

Basic Algorithm

Set up particle
While Animation In Progress
  If Particle Not Dead Then
    Add Particle Direction * Speed To Particle Position
    Add Particle Acceleration To Particle Speed
    Modify Particle Speed
    Modify Particle Energy
    If Particles Energy < Threshold Then
      Mark Particle As Dead
    End If
    If Particle Hits Object Then
      Modify Particles Positions, Directions, Speed and Energy
    End If
  End If
  Display Particle
End If
End While
Example: Movement of Particles

- $S_t$ is the state of all particles at time $t$
  - At $t=0$: $S_0$

Images: Greg M. Johnson
(http://www.geocities.com/pterandor/boids.html)

Example: Movement of Particles

- Compute the influence of all other particles within some range
  - Attraction, repulsion

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Example: Movement of Particles

☐ Add all forces together, and use that to update the current position

Wait, there might be other forces!

- Whatever the goal is of the scene
Example: Movement of Particles

- Again, sum these as the forces on the particle
- Repeat these steps for each particle

Images: Greg M. Johnson
(http://www.geocities.com/pterandon/boids.html)

Particle Systems: More Examples

- Fire
- Explosions
Particle Systems: Final Thoughts

- In many cases, ignore self collisions
  - What does two fire particles colliding look like?

- Very general framework!
  - We can make special cases to get specific effects
  - Just change rules, objects, etc.

- How would you represent this system in code?