Code the Universe Lecture #4

Sudhan Chitgopkar
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Connections

Walker
- Randomness
- Coordinate Systems
- Objects
- What-if?

Chaos Game
- Randomness
- Algebra & Trig
- What-if?

Artificial Life
- Vectors
- Algebra & Trig
- Objects
- What-if?

Bouncy Balls
- Vectors
- Collision Detection
- Algebra & Trig
- Objects
- What-if?

Fractal Trees
- Coordinate Systems
- Recursion
- Algebra & Trig
- What-if?

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Coffee Cup
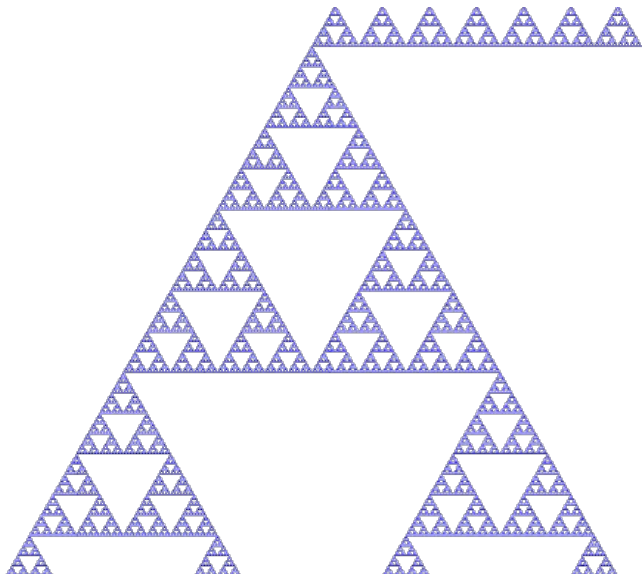- Coordinate System
- Algebra & Trig
- What-if?

Cellular Automata
- Coordinate Systems
- What-if?

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Cellular Automata

- Grid of cells with some state
  - For today, boolean state (what-if!)
- Cells change state as a result of *local* rules
  - Their neighbors – for today, 8-directional (what if!)
- **Local behavior lead to global patterns!**
- Lots of interesting rules/patterns here

Conway's Game of Life

- Simulates life, death, and population dynamics
  - Or bacterial growth in food [1]
  - Or growth of infected blood cells in the human body [1]
  - Or ant colony behavior [2]
- One of the most popular Cellular Automata
- [Turing-complete!](#)
- Rules:
  - If a cell is alive and has 2-3 neighbors, it stays alive
  - If a cell is alive and has 0-1 neighbors, dies (underpopulation)
  - If a cell is alive and has 4+ neighbors, dies (overpopulation)
  - If a cell is dead and has 3 neighbors, becomes alive (reproduction)

[1]: Nature-Inspired Computing Behaviour of Cellular Automata,
[2]: Mobile Cellular Automata Models of Ant Behavior: Movement Activity of Leptothorax allardycei
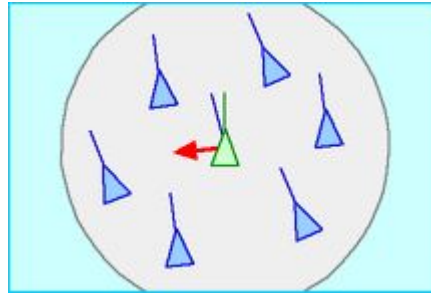
Artificial Life

- Simulates systems of natural life
  - Not restricted to cells, grids, and states
  - CA is a subset of Artificial Life
  - Can use ML or Genetic Algorithms
- Very rich field with lots of applications
  - Evolutionary Art/Music
  - Electric Sheep (fractals!)
  - Hardware
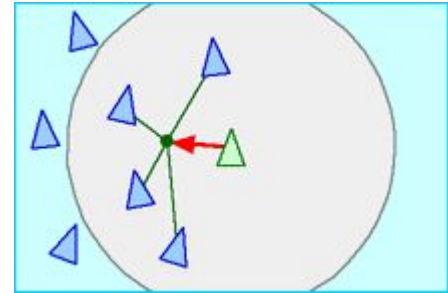 - Optimization

Reynolds & Boids

- Artificial Life simulation of bird flocking behavior
- **Local behavior lead to global patterns!**
    - Each "boid" can "see" a certain distance
    - It is in each boid's interest to follow certain rules
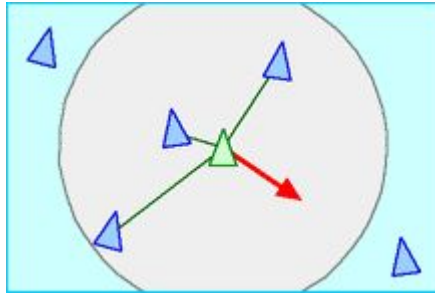
Separation   Alignment   Cohesion