Introduction to Agent-Based Modeling for Social Scientists

PART 1

with your host:

Charles Doriean

SCHEDULE

Week 1

Tuesday: What Are Agent-Based Models

- Brief History of Complex Systems and ABM
- Various Flavors of Agent-Based Models

Wednesday: What are ABMs made of?

- Various Flavors of Agent-Based Models (review)
- Components of all Agent-Based Models
- Model specific ABM components
- How to compare the value of different components
- Benefits and Limitations of Agent-Based Models

Thursday: Survey of ABM packages

- Do it Yourself from Scratch (C++, Java, etc.)
- Comparison of Swarm, AnyLogic, Ascape, NetLogo, and RePast
- Comparing NetLogo and RePast
- Analyze the Rabbit, Grass, Weeds Model
- Identify Lever Points in the Cooperation Model

SCHEDULE

Weeks 2 and 3

Before you Begin Building a Model...

- Can it be done in NetLogo?
- Find Code to Steal
- Locate Sources of Help (Internet and Human)

Practical Guide to Building NetLogo Models

- Simplicity or Speed
- Planning Algorithms before Writing Them
- Reuse as much code as possible (but not more)
- Tons of Examples and Explanations

Exercises and Applications

- Students will build models to develop skill and comfort
- Guided contruction of a chosen model

SCHEDULE

Week 4

Advanced Techniques and Extensions in Netlogo

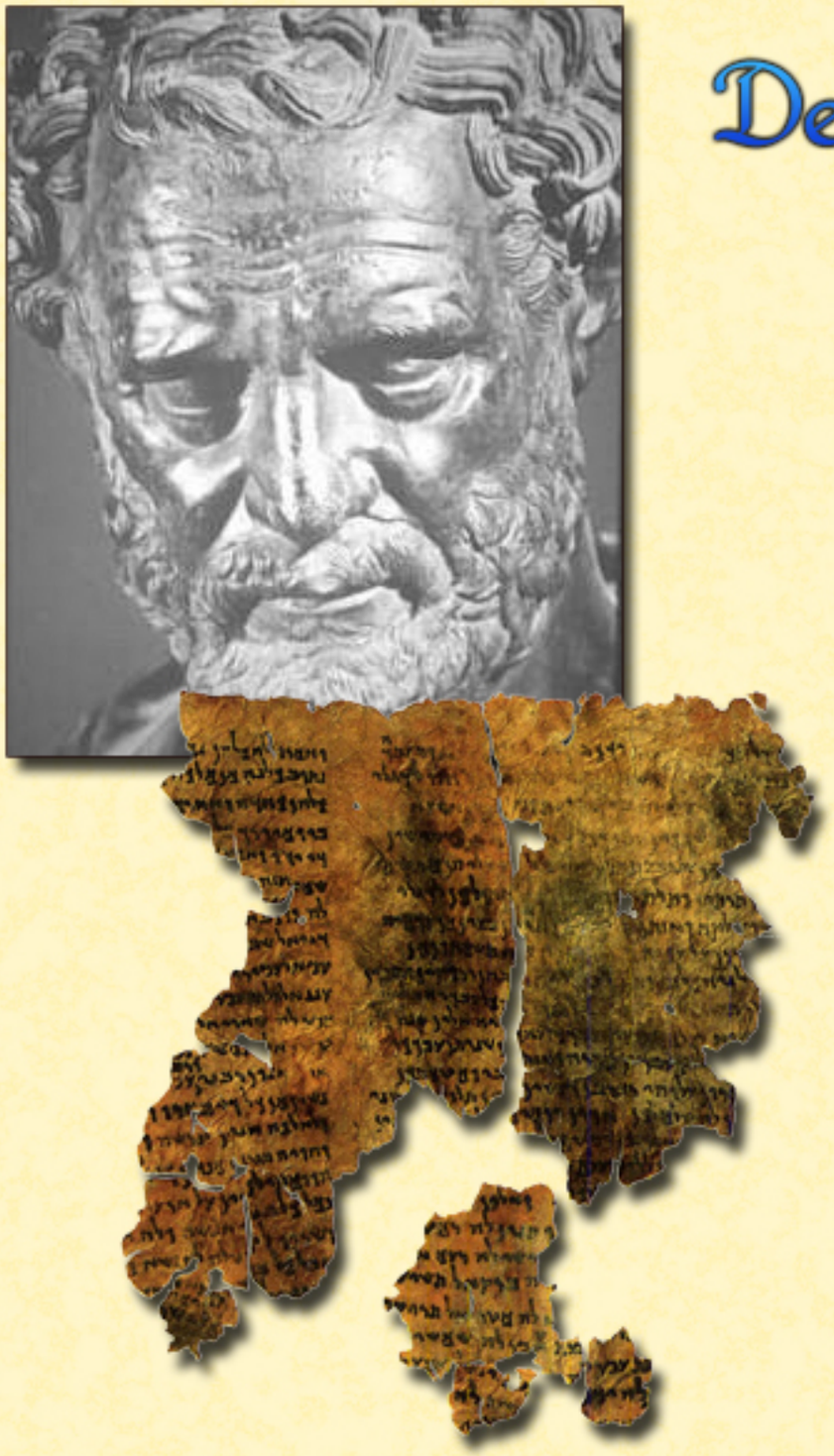
- NetLogo 3D
- Shapes Editor, Dynamical Systems, Behavior Space
- Networks, Functions, and Famous Kludges
- Java Extensions and Import & Exporting

Dealing with Data

- Batch Runs and Post Processing
- Metrics, Measures, and Modeling Magic
- The Folly of Statisitcs
- Are Your Results Viciously Built into the Model?

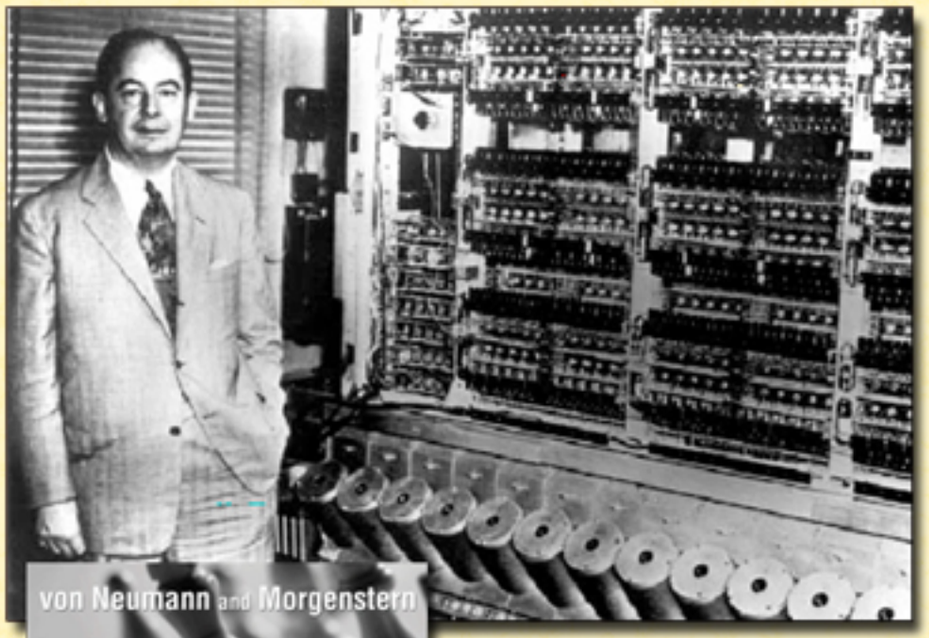
Developing and Working on Projects

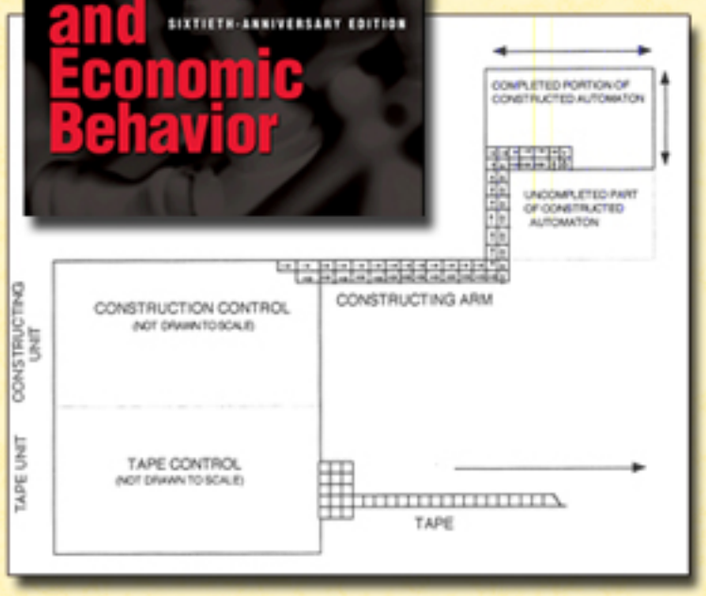
- Finding a Good Base Model
- Planning the Development Stages
- Work, Work, Work. Get 'er done!



Democritus

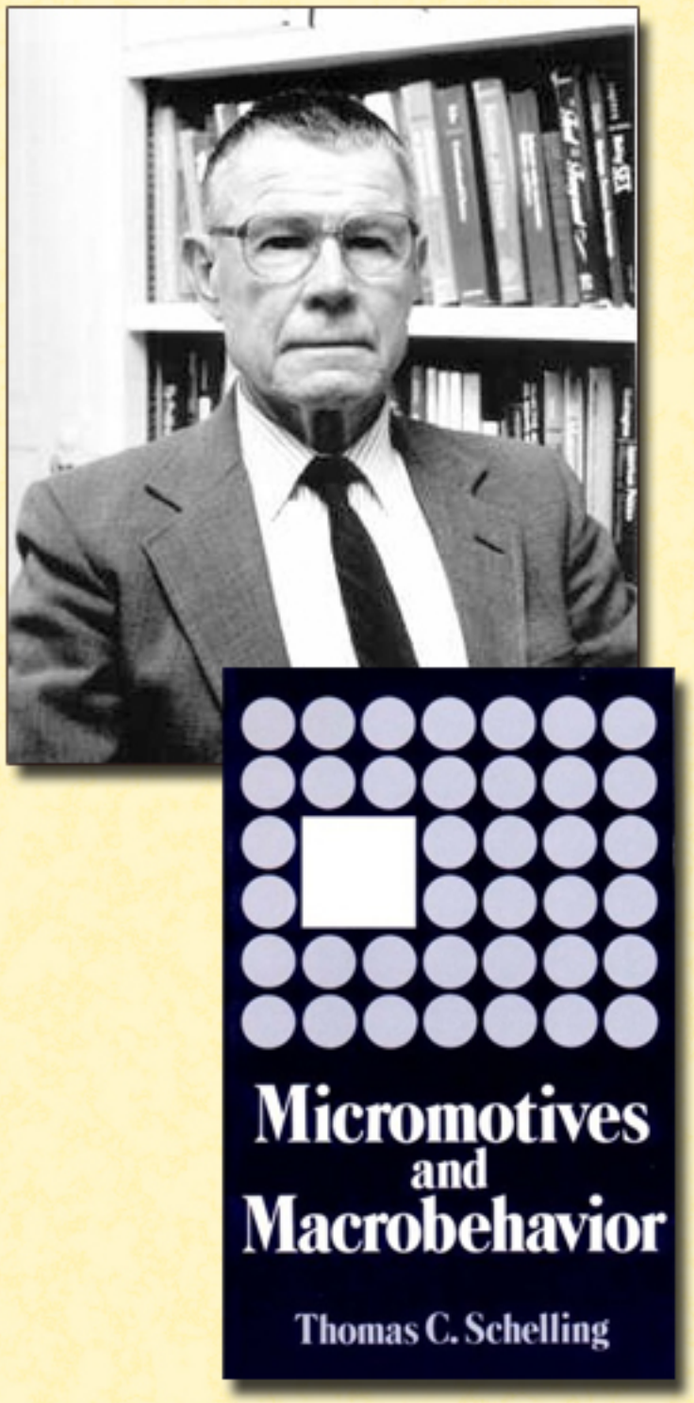
- Grandfather of Complex Systems
- Natural Philosopher 460-370 B.C.E.
- Co-Founder of Atomist Theory
- Very little first-hand work is known; most information is from second-hand accounts and may be bunk





John von Neumann

- Grandfather of Agent-Based Modeling
- Hungarian born Mathematician, 1903-1957 (died of cancer)
- Invented Game Theory
- Helped Develop Atomic Bomb
- Invented the Computer
- Invented Cellular Automata
- Figured out Godel's Incompleteness Theorem before Godel (but was nice)

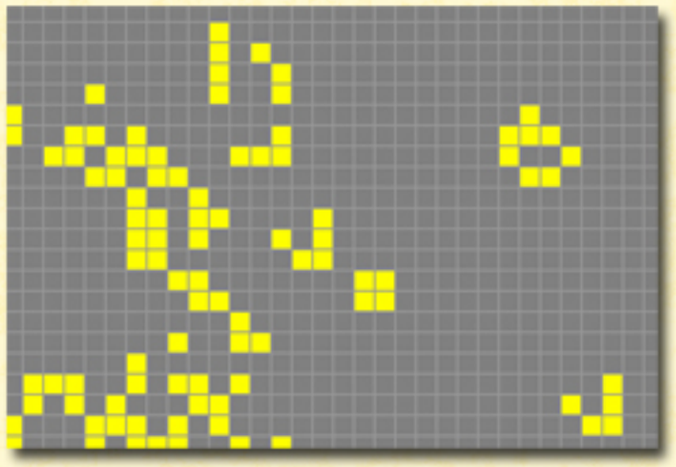


Thomas C. Schelling

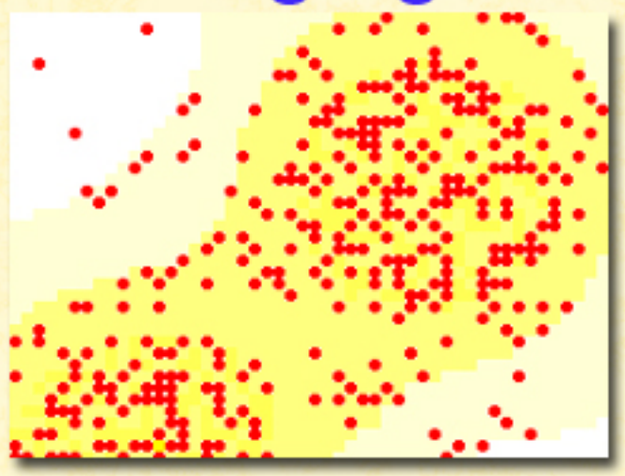
- Father of Agent-Based Modeling
- 2005 Nobel Prize Winner in Economics for work in Game Theory
- Clearly explained and motivated bottoms-ups approach in his 1978 book *Micromotives and Macrobehavior*
- Famous Segregation (aka "Tipping") model is the first modern agent-based model

Various Flavors of Agent-Based Models

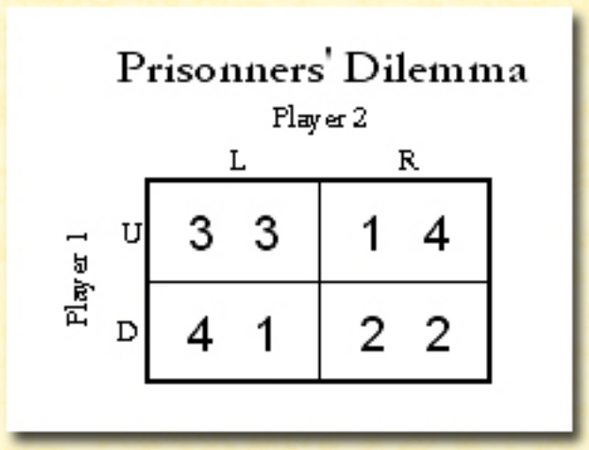
Cellular Automata



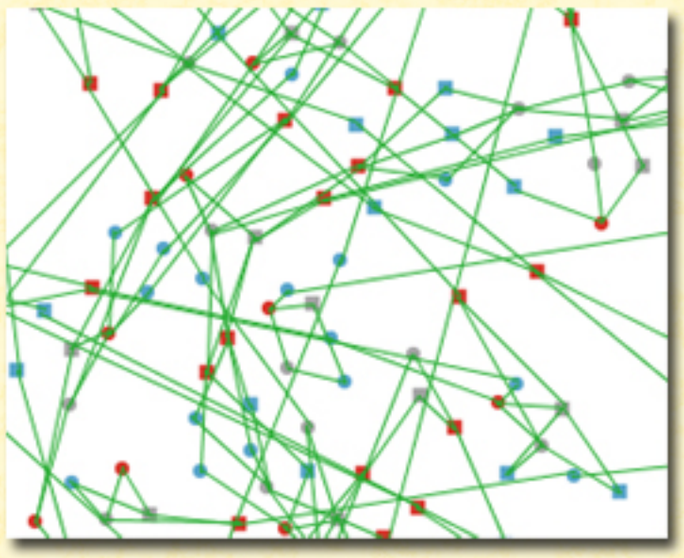
Free-Roaming Agent Models



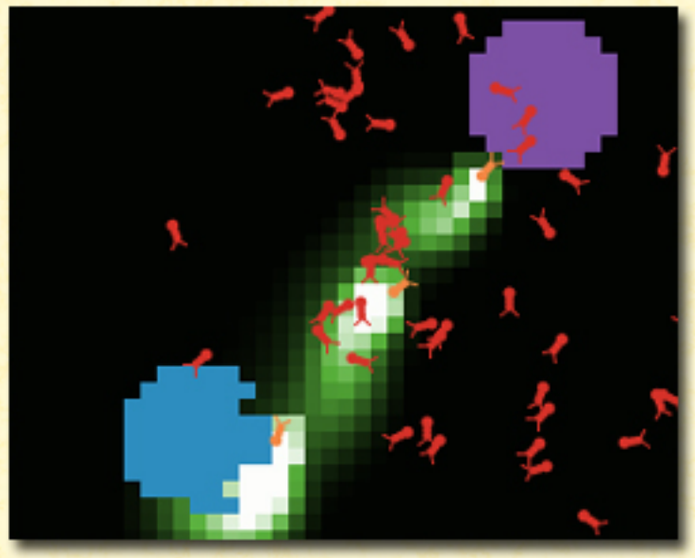
No-GUI Models



Network Models



Hybrid Models

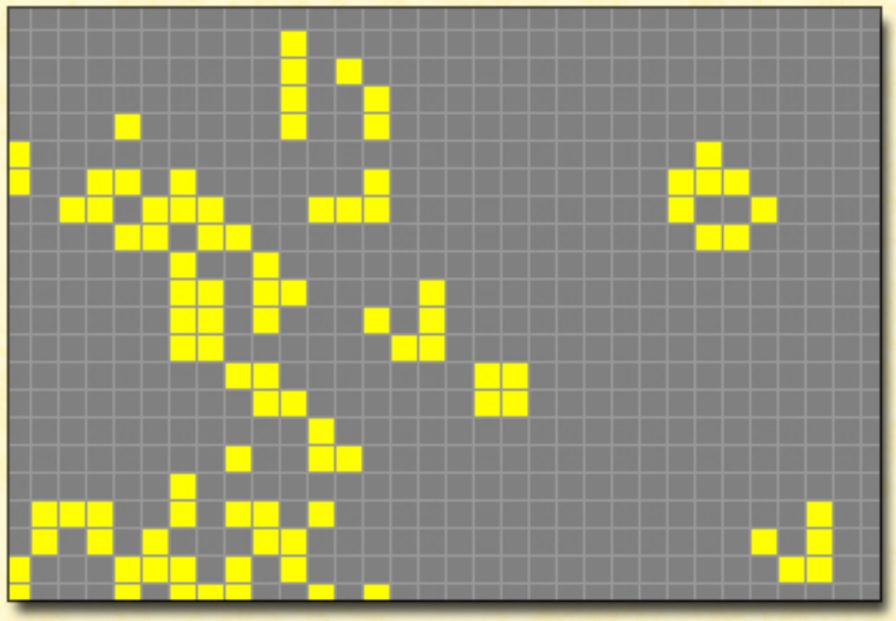


Various Flavors of Agent-Based Models

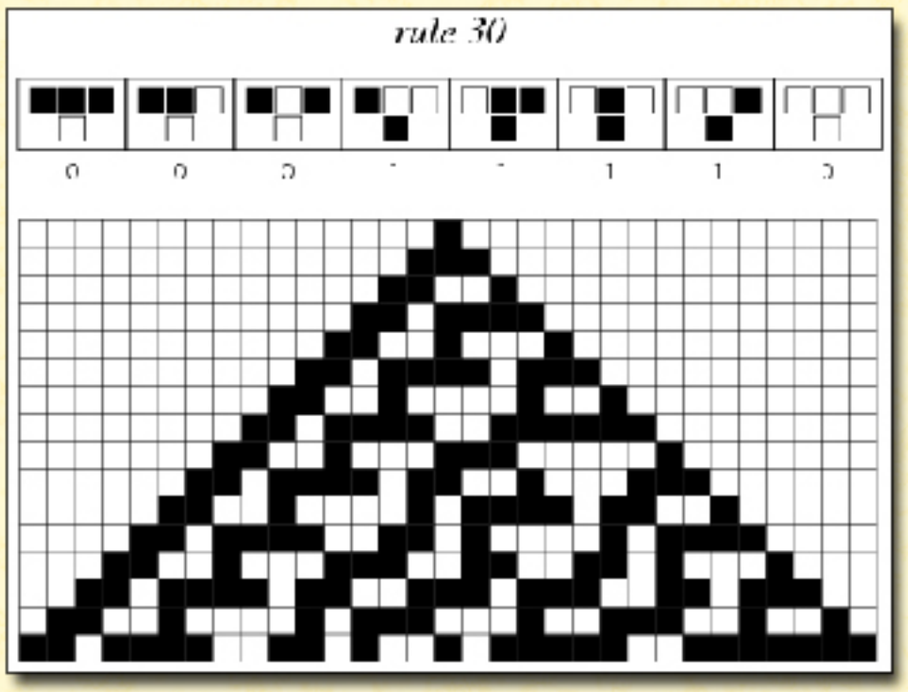
Cellular Automata

- World is Divided into Discrete-Sized Cells (Agents)
- First Kind of ABM - Invented by von Neumann
- Eg. Game of Life, Wolfram's Elementary CAs, Axelrod

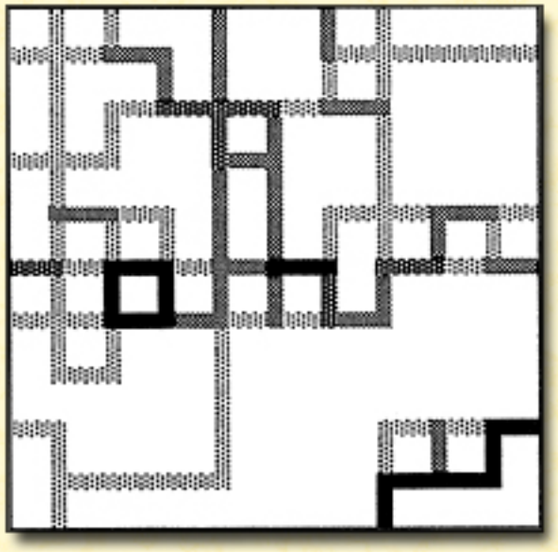
Conway's Game of Life



Wolfram's CA



Axelrod's Dissemination of Culture

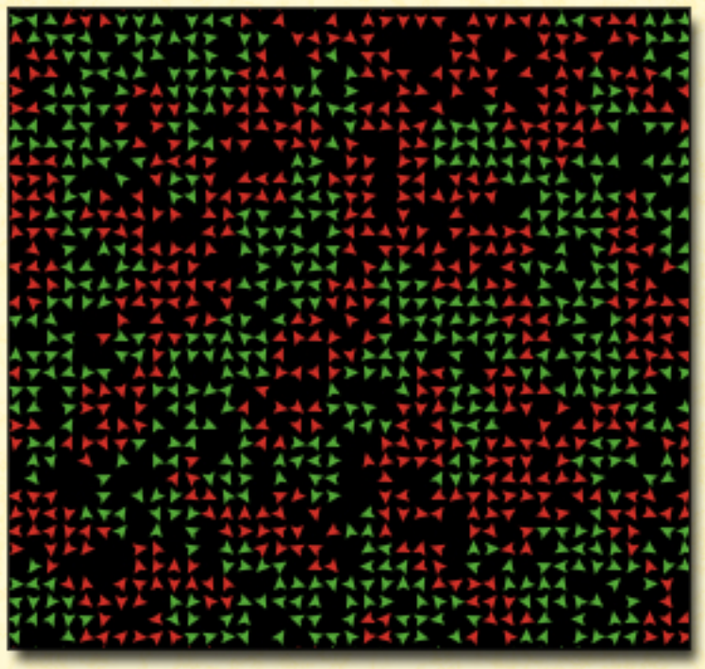


Various Flavors of Agent-Based Models

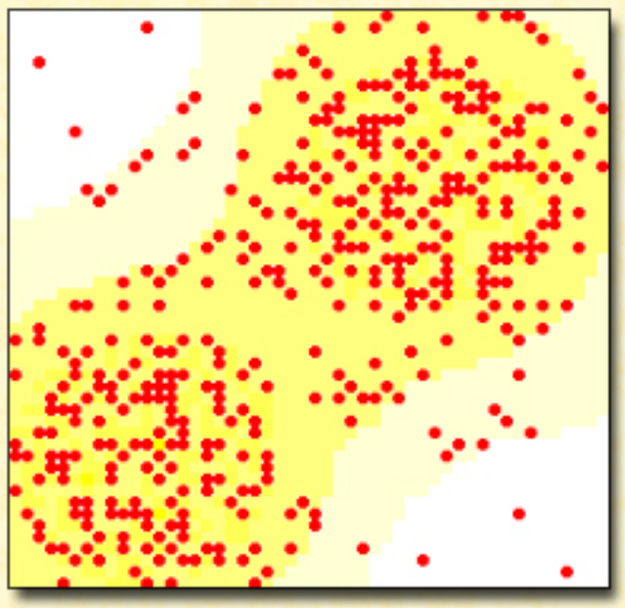
Free-Roaming Agent Models

- Mobile Agents (usually "more sophisticated" than CAs)
- Eg. Schelling's Segregation, Sugarscape, Flocks of Boids

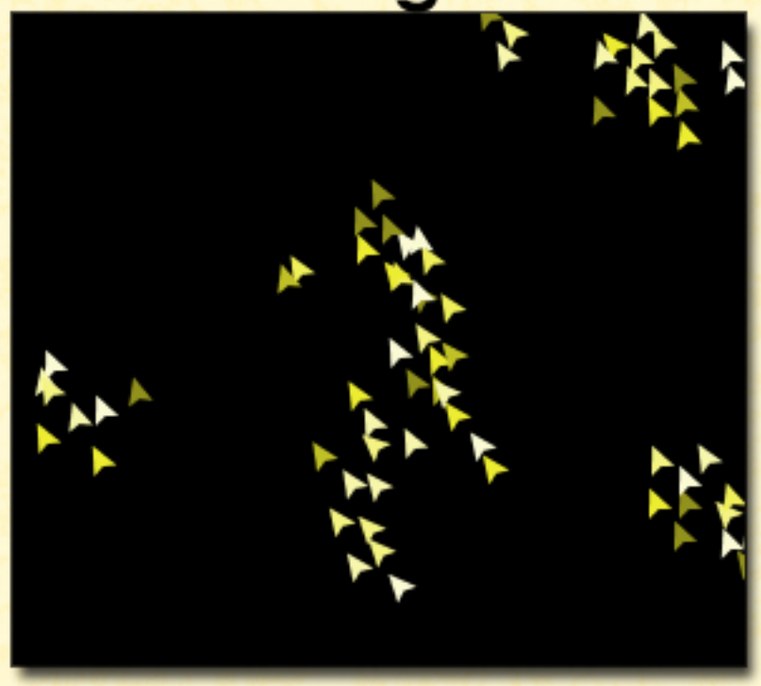
Schelling's Segragation



Axtell & Epstein's Sugarscape



Reynold's Flocking Boids

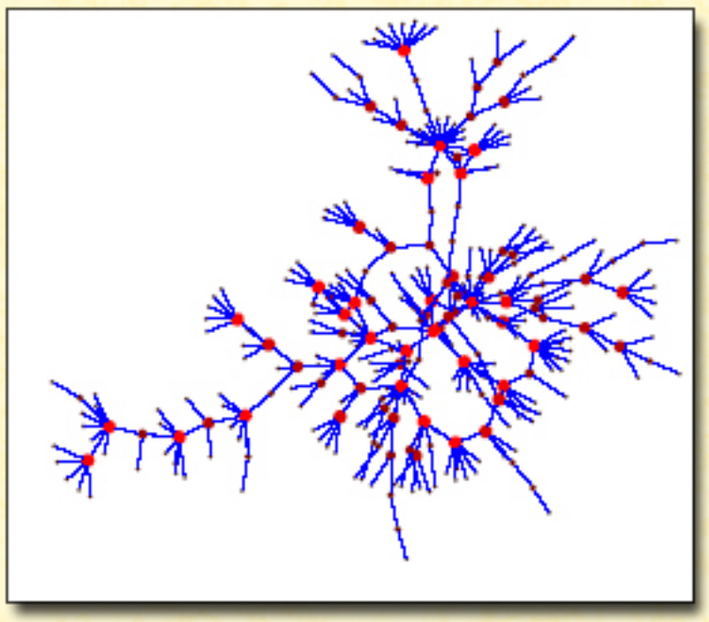


Various Flavors of Agent-Based Models

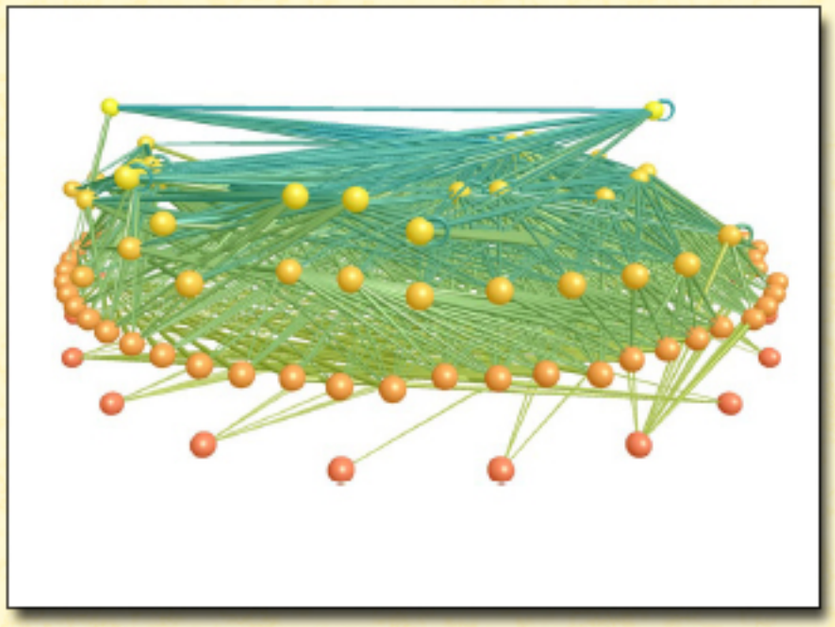
Network Models

- Agents are Connected Independent of Location
- Network Structure Provides some System Metrics

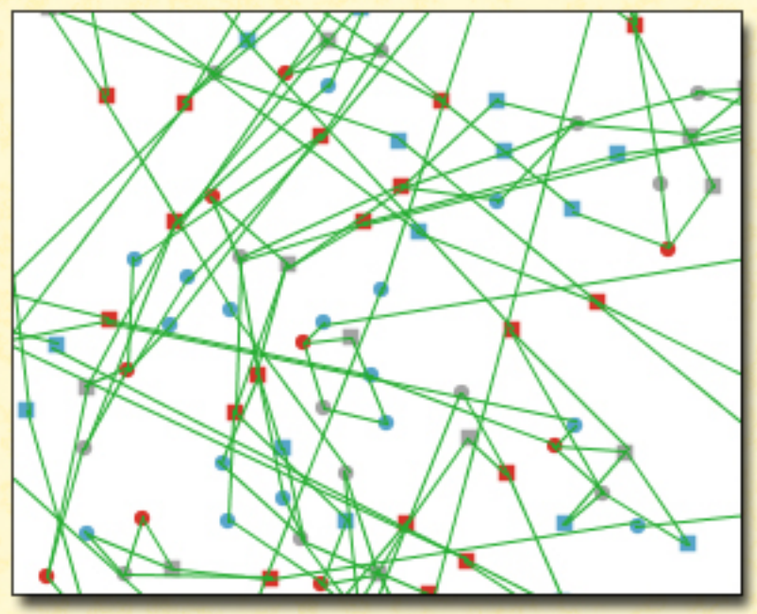
Potterat's HIV Tranmission



Martinez et al Food Web



Bramson's Population Scaling

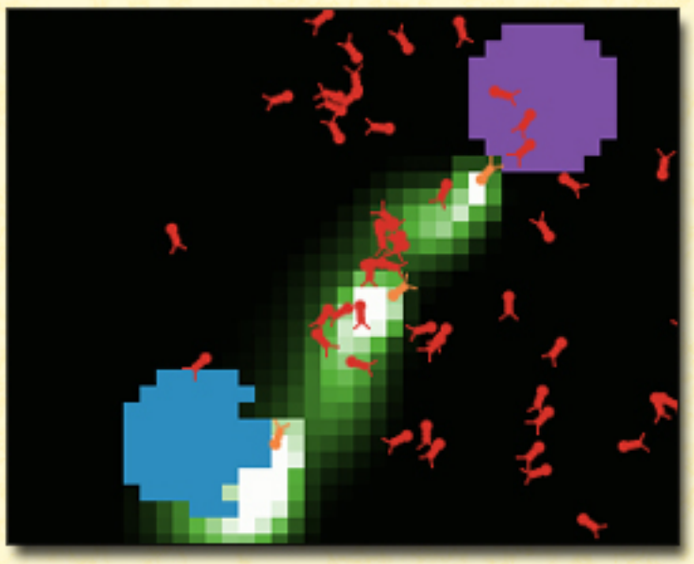


Various Flavors of Agent-Based Models

Hybrid Models

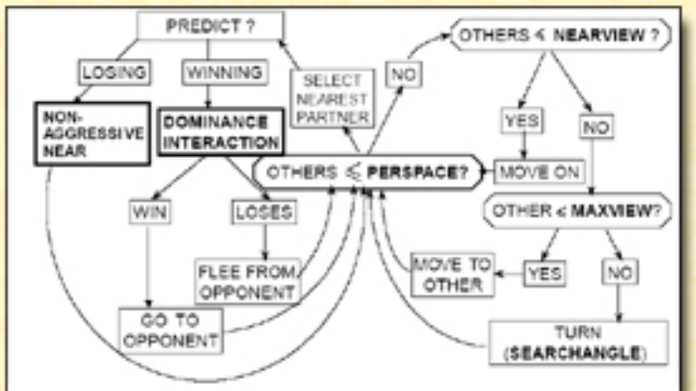
- Free-Roaming Agents on a CA Space
- Spatially Explicit World plus Social Connections

Ant Pheromones



Epstein's Smallpox Containment

Hemelrijk's Social Emergence



$$w_i = \begin{cases} 1 & \frac{DOM_i}{DOM_i + DOM_j} > RND(0,1). \\ 0 & \text{else} \end{cases}$$