

Aaron Bramson's

Introduction to
Agent-Based
Modeling

DAY 3

Is an Agent-Based Model What You Need?

What Characteristics of the Behavior are Essential?

- Perspective A: use Occam's Razor - simplest model possible
- Perspective 1: use Kitchen Sink - put in everything
- Complex Systems Exhibit Opaque Attribute Contexts

Which Modelling Techniques(s) Can Capture Them

- Differential Equation Model: dynamic behavior with equilibria
- Statistical Model: predicting behavior through historical analysis
- Analytical Models: equation based with closed form solutions
- Real-World Experiments: scaled-down replica of actual system
- Agent-Based Models: open-ended rule-based computer simulations

Who Will Use the Model and for What?

- Personal Experimentation vs Student Pedagogy
- Prediction, Exploration, Explanation, and/or Existence Proof

What are your Skill/Time Restrictions?

Is an Agent-Based Model What You Need?

Benefits

- Implicit NonLinear Dynamics (Feedback & Dynamic Interactions)
- Spatially Explicit
- Heterogeneous and Adaptable Agents
- “Medium” Number of Agents
- Adaptable/Evolvable System Characteristics
- Exponential Increases in Computer Power
- Plagiarism is Encouraged and Rewarded
- Visualization Can Pump Intuitions and Impress Others

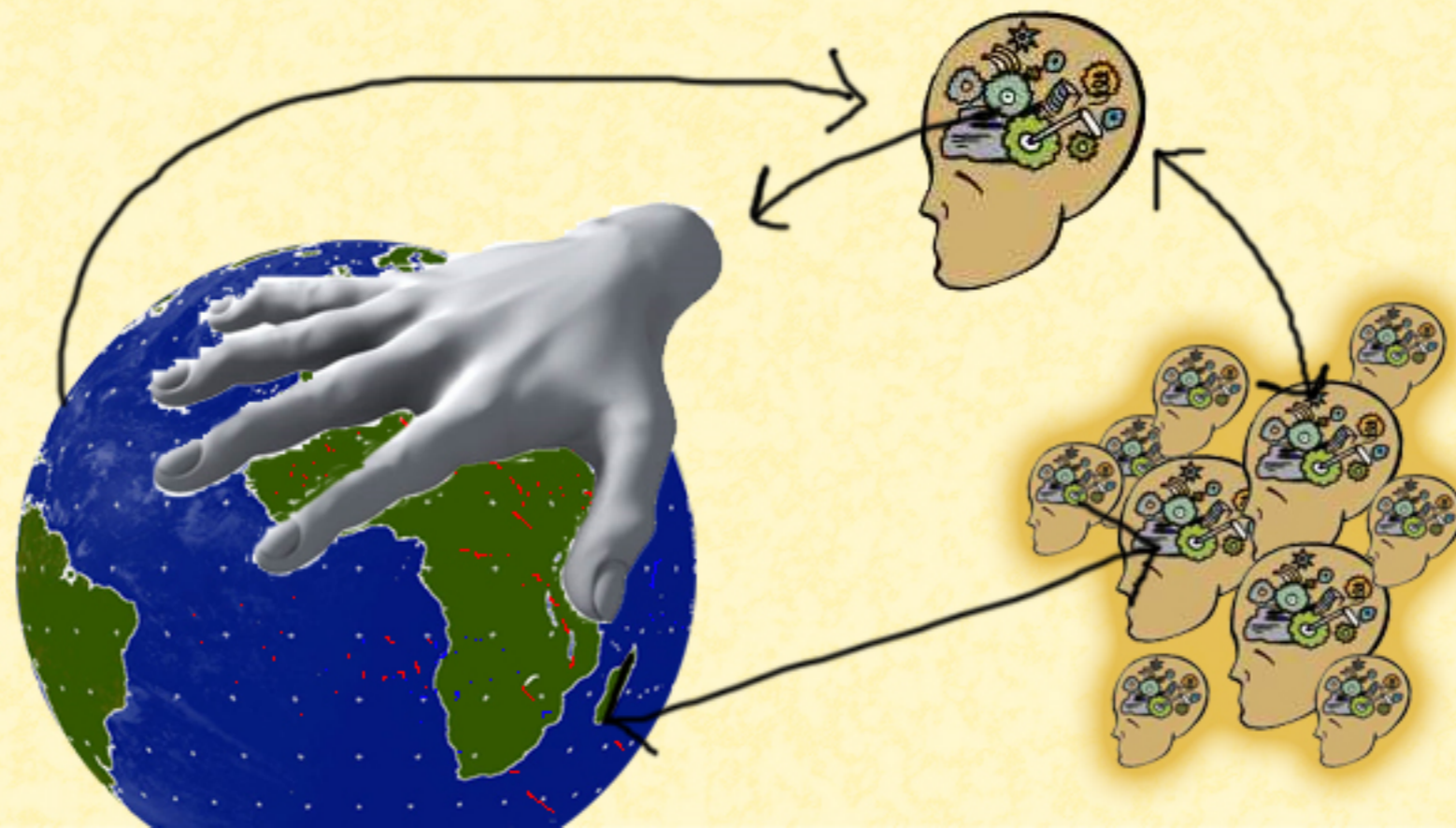
Limitations

- Difficult to Analyze Results and Causal Mechanisms
- Social Stigma Against ABMs
- Practical Limits of Computing Power
- Requires some Computer Programming Ability

Components of Agent-Based Models

Agents

- Rule-Based Behavior (Possibly Learning & Adapting)
- Interact with the World and Each Other
- Between Two and One Duotrigintillion Agents

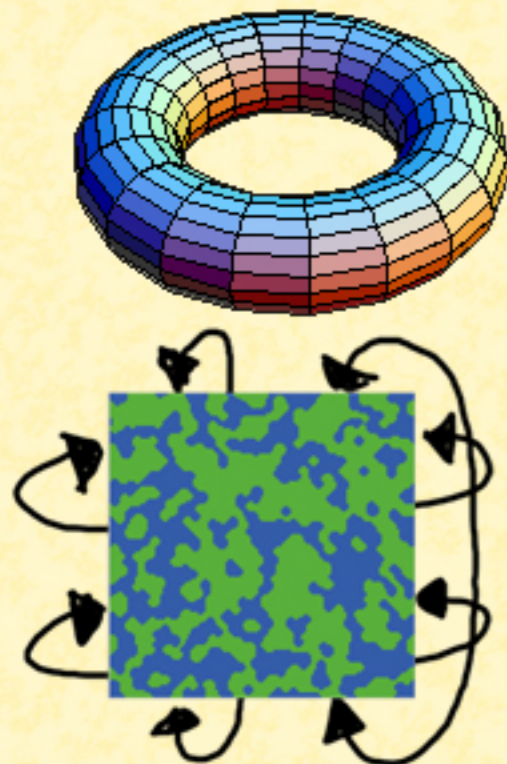


Components of Agent-Based Models

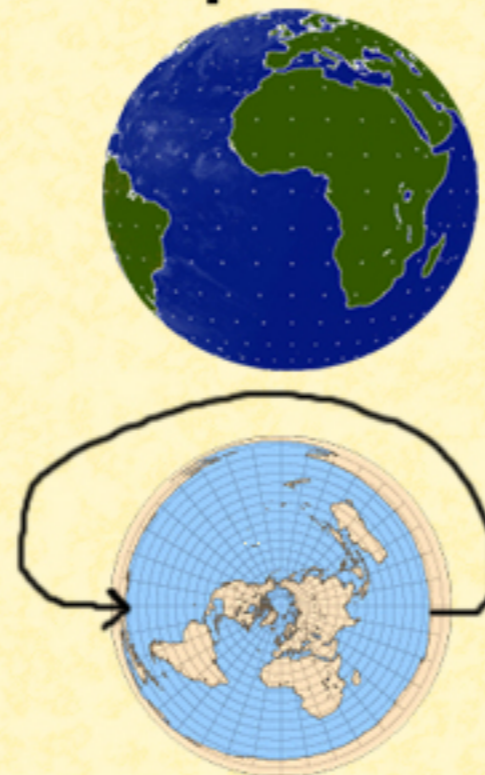
World

- Pick Your Dimensions: zero through infinity
- Bounded vs Wrapped (Rings and Toroids)
- Holds Values (Environment) which May Be Dynamic
- Divided into Discrete Space or Not

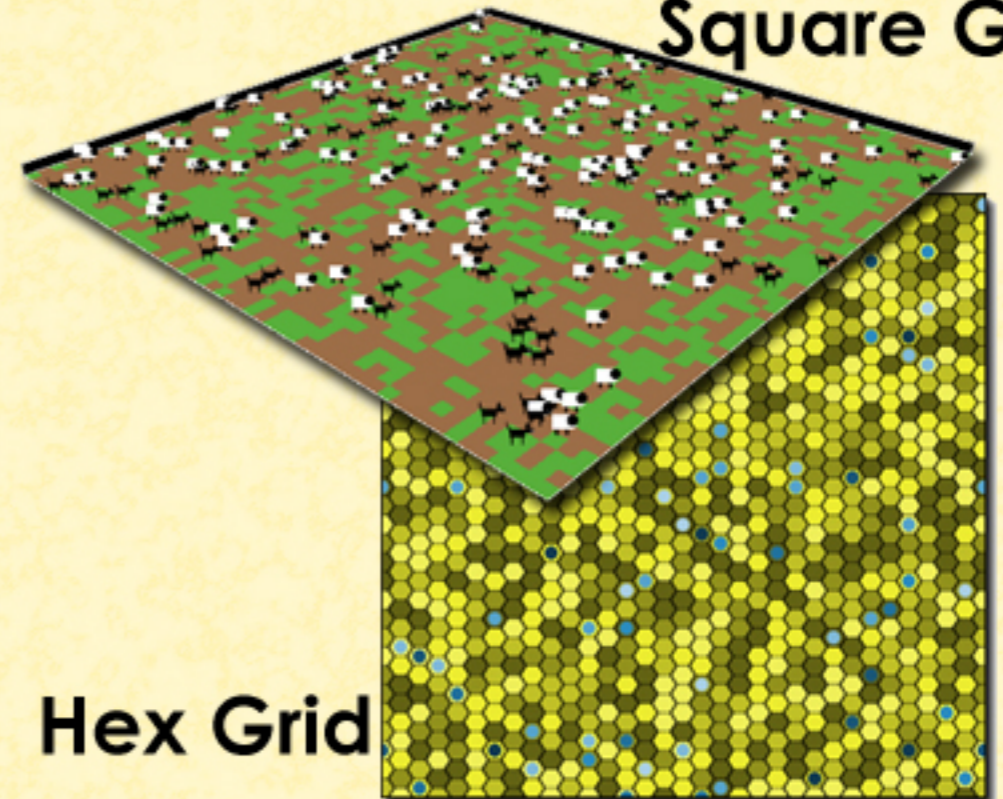
Torus



Sphere



Square Grid

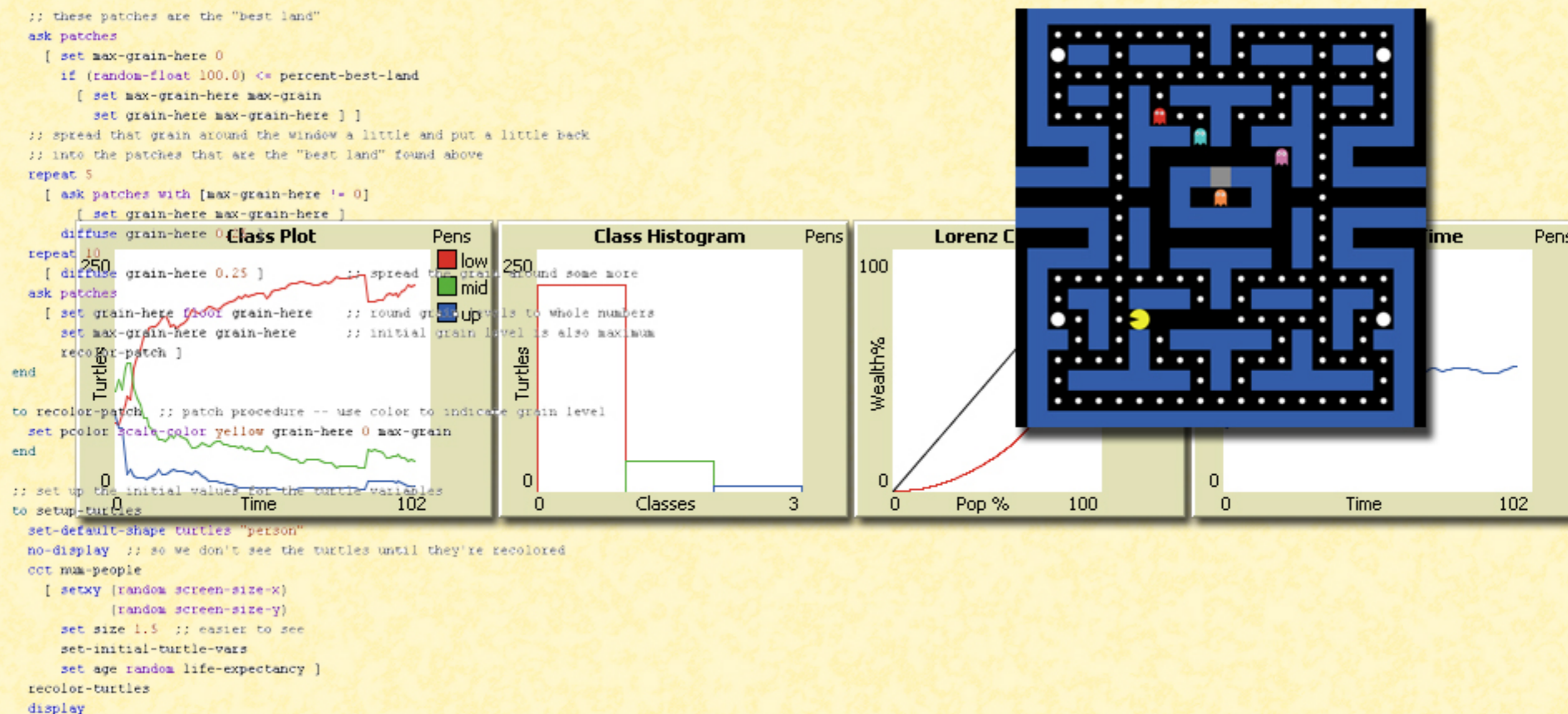


Hex Grid

Components of Agent-Based Models

Other Common Elements

- Resources, Obstacles, Landmarks as “Agents”
- GUI, Graphs, Reports, Documentation, ...



What are Agents Based Models Made of?

Space and Movement

- Space Measure (e.g. Distance) in 1D, 2D, or absent?
- Exogenous vs Endogenous Movers (Preferences vs Wind)

Complicated Agents

- CAs and Pure Networks Limit Agent Abilities
- Learning vs Adapting vs Evolving
- Agents using AI and internal models

Model Dynamics

- Agent Birth and Death
- Agents Exchanging Resources and Information
- Agent-Environment Feedback

What are Agents Based Models Made of?

User-Defined

- Set by users during setup or dynamically
- Initial Conditions or Boundaries
- Takes a Range of Values (Sweepable)
- Define Range and Granularity

“Tweaked”

- Hidden Parameters (Hard-Coded)
- Set at Values that are Known to “Work”

Distributions

- Select Type of Distribution (Normal, Exp,...)
- Select Distribution Parameters

Everything Must Be Decided

BY YOU!



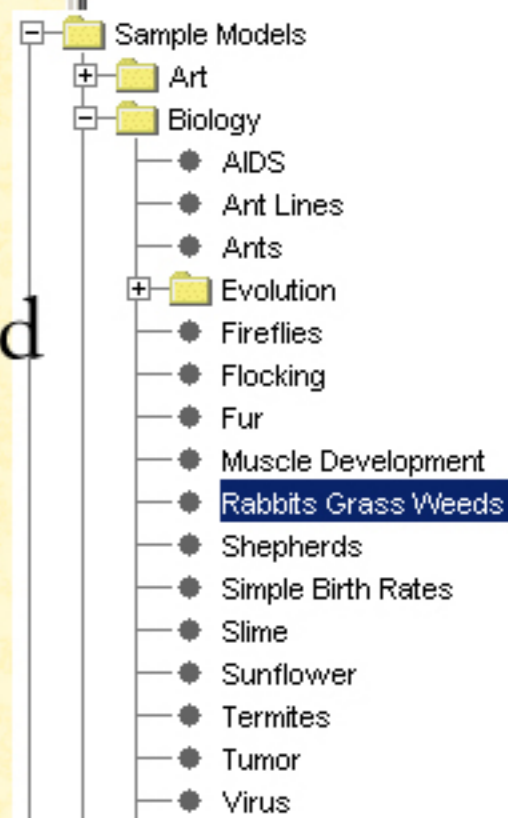
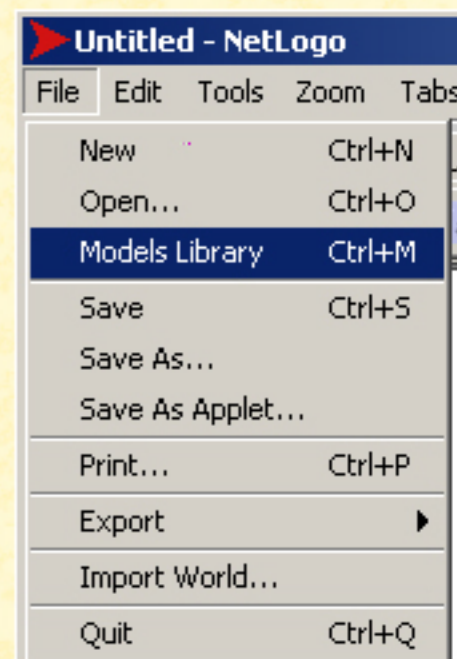
Hands-On Modeling Examples

Opening and Running a Model in NetLogo

- If You Have an .nlogo File, Just Double-Click It
- Go to the File Menu, Click “Models Library”
- Search through the Models *and* Code Examples
- Double-Click One or Select It and Click “Open”

Running a NetLogo Applet

- Click the Link to a NetLogo Applet
- Wait for the Java Run Time Environment to Load
- Rejoice if it Works



Hands-On Modeling Examples

Identify Characteristics of Rabbit Grass Weeds

- What Type(s) of Models? CA, Free Agents, Network, Hybrid
- What Kinds of Agents Are there?
- Any Agent-Agent Interaction? Describe.
- Any Agent-World Interaction? Describe.
- Bounded or Toroidal World? Does the World Hold Values?
- What Are the Parameters? Any Hidden Parameters?
- What Does the Model Report?
- How Does Changing the Parameters Effect Model Behavior?
- How Does It Effect Model Performance?
- What Else Could You Use this Model for (in Whole or Part)?

Hands-On Modeling Examples

Adjust Parameters to Achieve Cooperative Outcome

- How do the Parameters Effect Agent Behavior?
- How do the Parameters Effect World Behavior?
- Are there Long Term/Short-Term Trade Offs?
- What Set(s) of Parameters Yield the Cooperative Outcome?
- Would Looking at the Code Make this Easier?

