# *Swarm And Theory*

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# *Overview*

- Metatheory
- Problems/Challenges of ABM

# *There's theory*

- Anne Elke's theory about brontosauruses.

# *And then There's Theory*

- Spatial Model of Congress.

# Division of the question

Figure 6.15
Equilibrium Induced by
Division of the Question

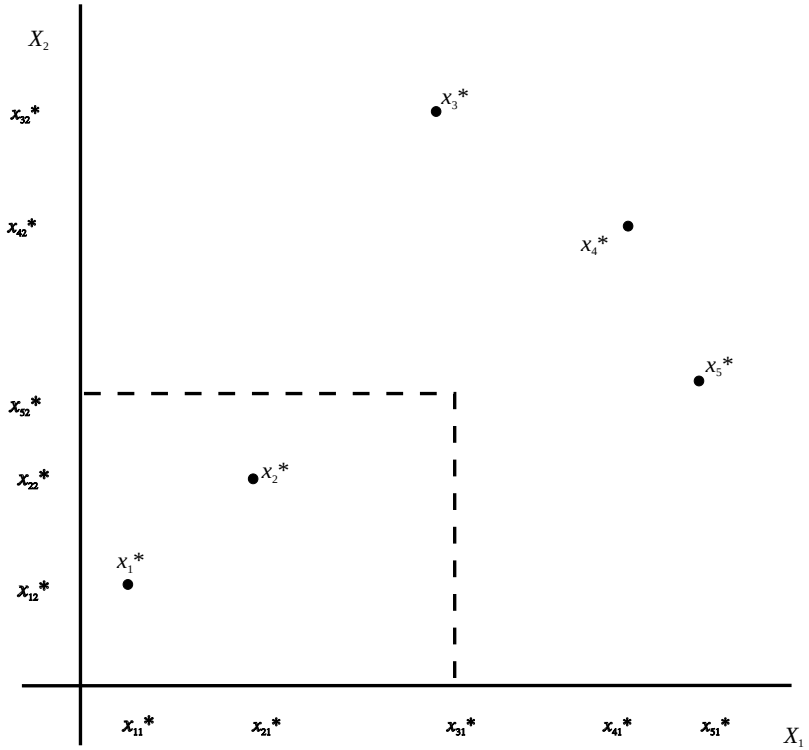
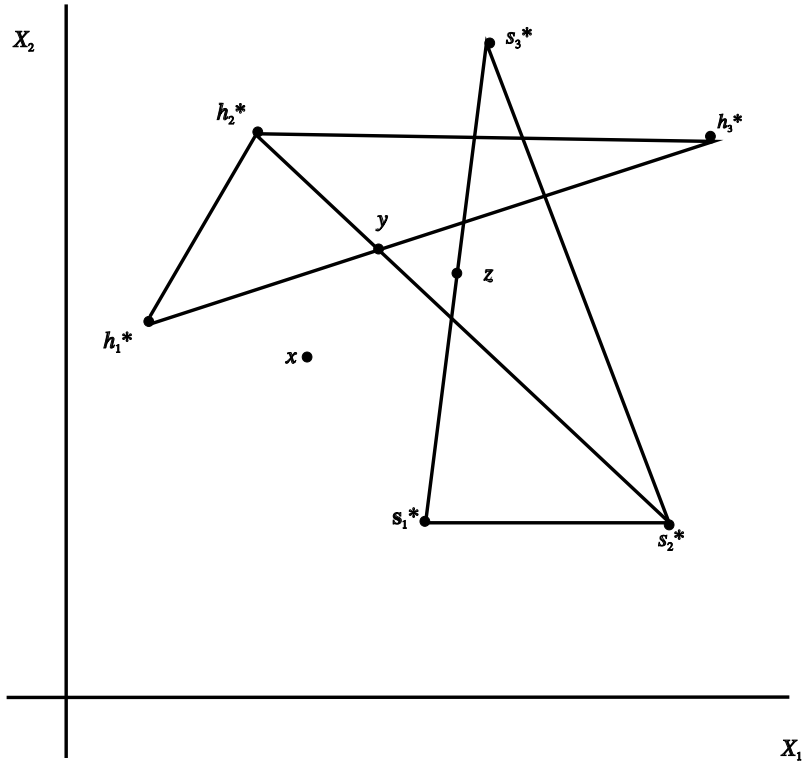


Figure 6.18
Bicameral Legislature with
Structure Induced Equilibrium



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## *What's the Diff?*

- A small-t theory is an empirical characterization
- A big-T theory is a set of "working parts" such that
  - it can be "deductively interrogated".
  - most "unknowns" are "interesting" (worth debating)
- It is a plus if a Theory
  - relates easily to observables
  - mathematically workable (allows $\frac{\partial s^*}{\partial \beta}$)

## *Common Problem: Too Big of a Belt*

Hempel's old philosophy of science. Theory has

1. Core Elements. (Structures in which we are interested)
2. Auxiliary Elements/hypotheses. (To link/adjust Core to data and make it testable, a set of ad hoc insertions is typically necessary.)

Generally, a better theory has more 1 than 2.

# *Now Infamous Nash Equilibrium*

Reduce a setting to

1. A list of agents, N
2. Sets of possible actions $S = \{S_1, S_2, ..., S_N\}$,
3. A payoff function which designates for each agent a payoff function that corresponds to each possible action:

$$U : \prod_{i \in N} S_i \rightarrow \Re^N$$

## *Nash's solution*

- A "solution" or "**equilibrium**" is a vector of actions $s^* = (s_1^*, \ldots, s_N^*)$ such that no individual can obtain a higher payoff by a unilateral change of action.
- Nash's theorem gave conditions under which a solution will exist and employed then-recent results in fixed-point theory to prove it.

# *A Beautiful Theorem*

This theorem gave:

- analytical backbone to pre-existing theories in Economics
- a clear modeling path for new projects in other fields
- tied into very useful theorems from Math
- allows comparative statics–"what if" conjectures about framework/institutions

# *Problems with Nash approach*

"Unrealistic" (not relevant?) characterization of human

- institutions and settings
- individual information about other players
- calculation capability
- isolation of one decision from another

## *Problems with Nash approach*

Difficulty in applying when there is a large

- number of agents
- countable strategy sets
- sets of equilibrium points
- differences among agents in interest

# *Agent-based modeling*

- Promise: incorporate and test “new ideas”
- Problems:
  - Big Belt: many ad hoc model details
  - Difficulty isolating “solution” concept

# *Protest Modeling*

Gaps in existing social theories.

- “relative inequality” or other theories do not meaningfully explain individual-level dynamics

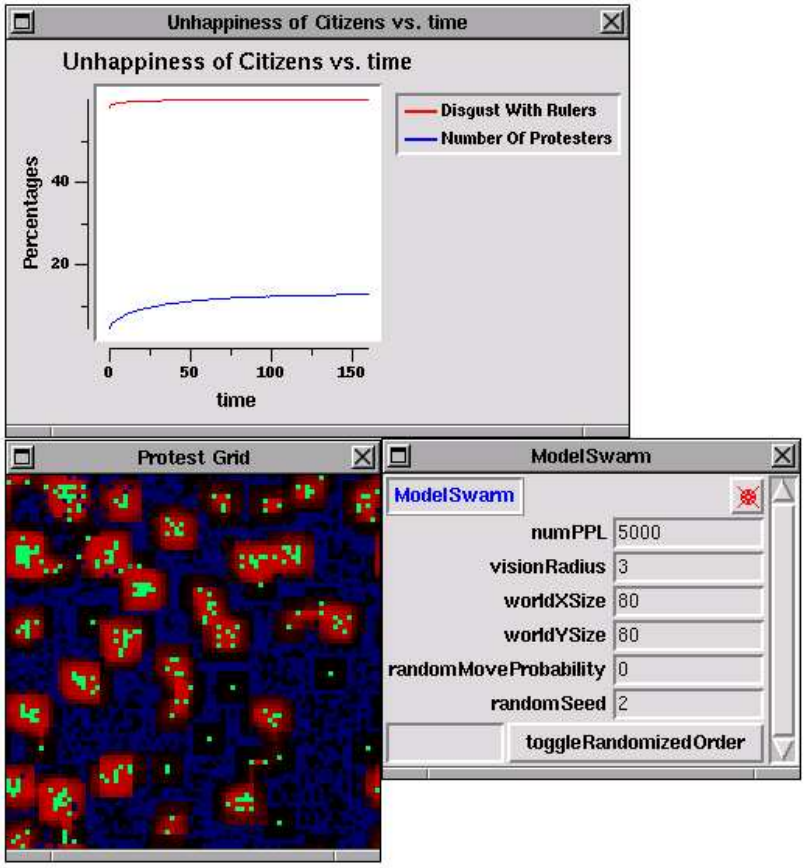
Swarm model:

- Agents try to measure quality of ruler by observing the number of protesters they see inside a neighborhood.

# Protest 1

Figure 6

Contagious Protest



# *Details, Details*

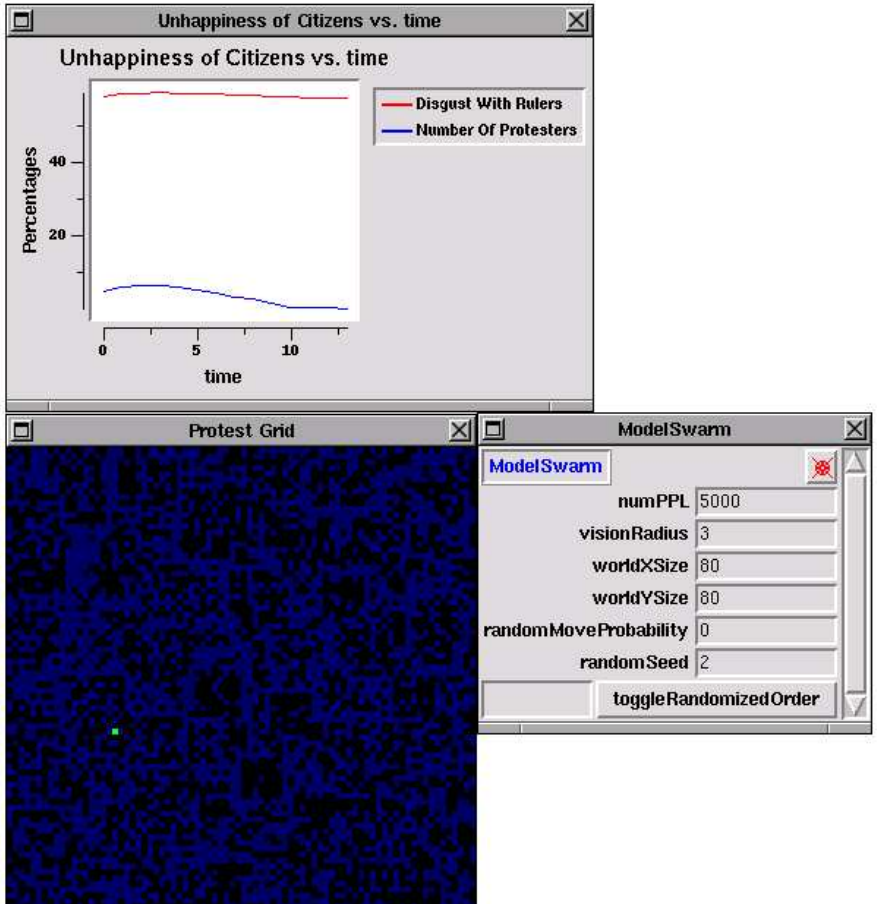
Many Auxiliary hypotheses

- Density of agents
- Vision radius
- “free time” or exhaustion factor
- How/why should they move around?

# Protest 2

Figure 8

Protest Model with Exhaustion Factor

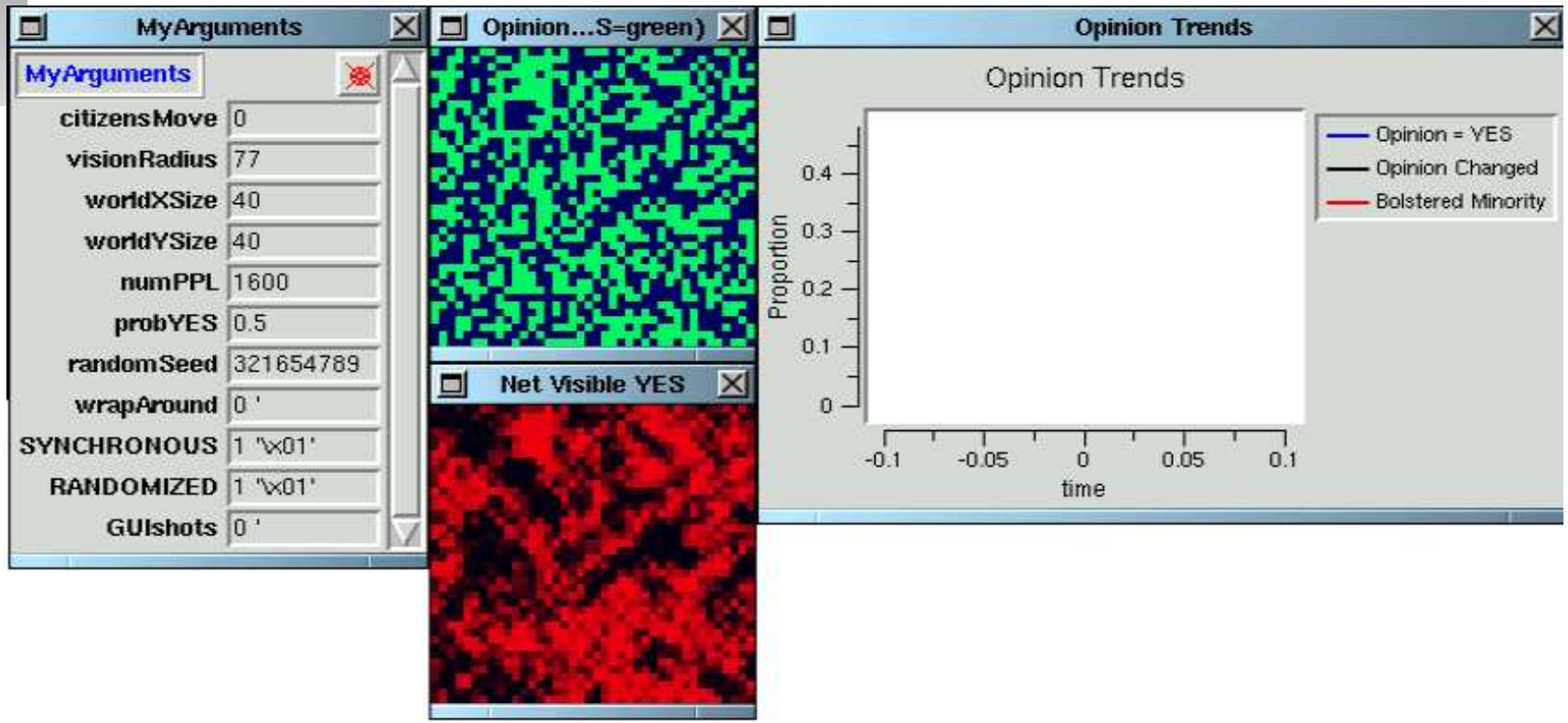


# *Social Impact*

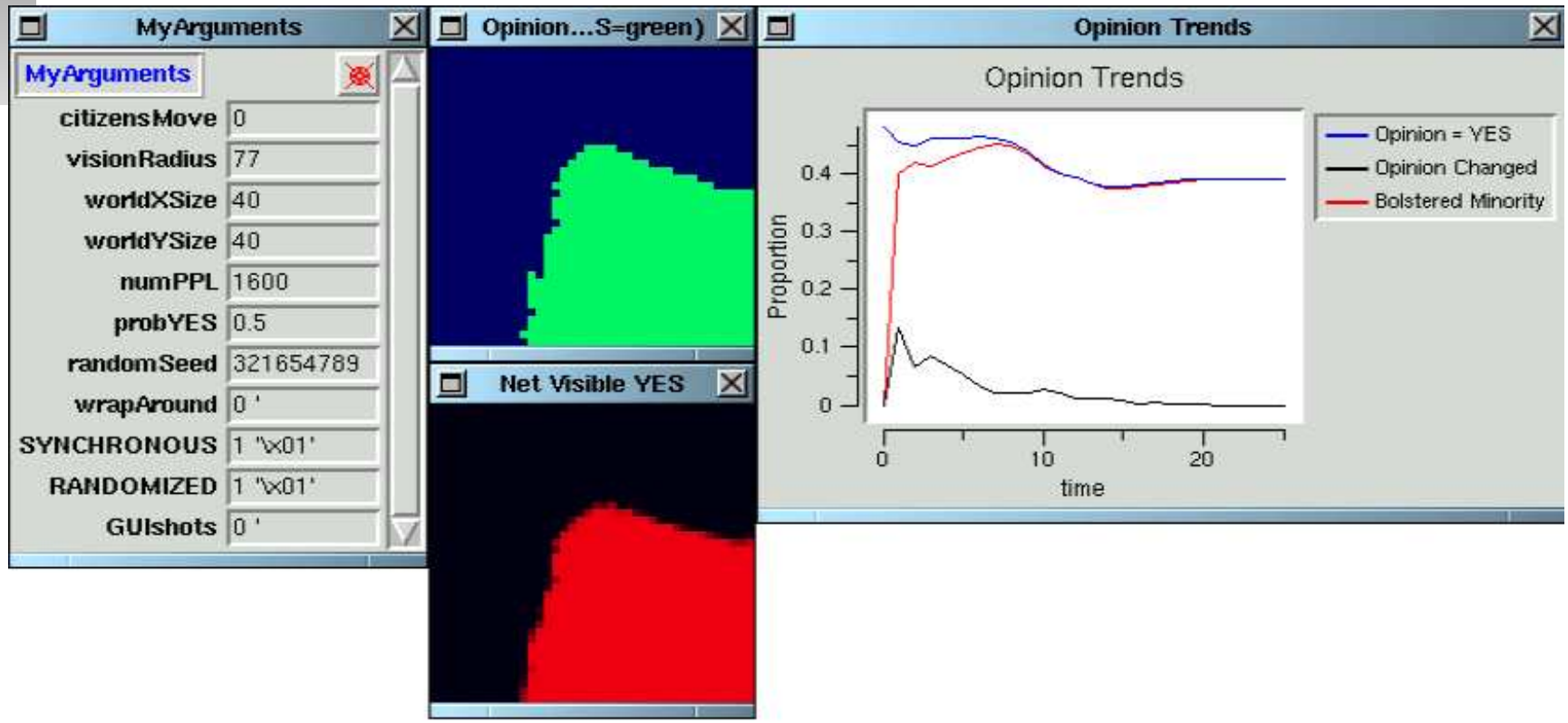
Bibb Latane (et al) model of agents in a grid who may be persuaded by social influences.
Key Features:

- Agents fixed in position, evenly dispersed
- Pressure emanates radially from each agent, stops at border of grid
- Synchronous (all update against snapshot)

# Impact Snap1



# Impact Snap 2



# *Consider Generalizing SI model*

Modeling Features we can introduce

- Mobile agents
- Asynchronous updating
- Limited impact: radius X
- Impact may wrap (toroidal world)

# *Does Generalizing Help?*

Yes:

- Undercuts previous results driven by ad hoc elements
- Fills gaps in theory that underlies model

No:

- How many angels can dance on the head of a pin?