Models of Social Dynamics
An Introductory Module

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Unit 3: Opinions
Opinions, attitudes, and beliefs

A position on some issue

- How good is cake?
- Is Batman really a hero?
- Is the theory of Natural Selection true?
- How much should one pray?
- How many licks does it take to get the Tootsie Roll center of a Tootsie Pop?
A model of opinion dynamics requires assumptions of three categories:

1. A representation of opinions, attitudes, or beliefs
2. A mechanism for social influence
3. A population structure
A representation of opinions

• Ultimately, we might want something sophisticated, like a multidimensional semantic network.

• For now, let’s start simple. A vector in which each item is an independent opinion, that can take on continuous or discrete values.

• Continuous values:
How do opinions change as a result of social interaction?

- **Positive influence.** Agents interact and become more similar.

- **Bounded confidence (or biased assimilation).** Agents ignore those who are sufficiently different.

- **Negative influence.** Agents interact and become more *dissimilar* from those that differ sufficiently from them initially.
A population structure

Who interacts with whom?

Random mixing

Square lattice
The Bounded Confidence Model

- Two agents, with opinions $x_1$ and $x_2$, interact and influence each other if and only if $|x_1 - x_2| < d$.

- If they interact, opinions are updated thusly:
  
  $$x_1 \leftarrow x_1 + k(x_2 - x_1)$$
  
  $$x_2 \leftarrow x_2 + k(x_1 - x_2)$$

  ![Diagram of the Bounded Confidence Model](image-url)
Lattice neighborhoods

von Neumann neighborhood

Moore neighborhood

we’ll use this one
the bounded confidence model

**CODE:** opiniondynamics_BC.nlogo
Results (non-spatial)
Results (non-spatial)
Results (non-spatial)
Results (non-spatial)

Lower confidence thresholds lead to more cliques

Initial opinion is imperfectly related to final opinion

from Deffuant et al. (2000)
Results (spatial)
Results (spatial)
Results (spatial)
Negative Influence

- Two agents, with opinions $x_1$ and $x_2$, interact.
- If $|x_1 - x_2| < d$, they exert positive influence on one another.

\[
\begin{align*}
x_1 & \leftarrow x_1 + k(x_2 - x_1) \\
x_2 & \leftarrow x_2 + k(x_1 - x_2)
\end{align*}
\]
Negative Influence

- Otherwise, they exert **negative influence** on one another

\[
x_1 \leftarrow x_1 + k(x_1 - x_2)x_1 \\
x_2 \leftarrow x_2 + k(x_2 - x_1)(1 - x_2)
\]
bounded confidence model with negative influence

**CODE:** opiniondynamics_neginfluence.nlogo
Results (non-spatial)
Results (non-spatial)

negative influence, $d = 0.4$

negative influence, $d = 0.1$
Results (spatial)
Results (spatial)

$d = 0.5, \ t = 70,000$

$d = 0.35, \ t = 25,000$

$d = 0.1, \ t = 25,000$
Opinion dynamics:
a young field
Further directions

Differentiation

Gérard Weisbuch (2015)
From Anti-Conformism to Extremism
Journal of Artificial Societies and Social Simulation 18 (3) 1
<http://jasss.soc.surrey.ac.uk/18/3/1.html>

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Abstract

We here present a model of the dynamics of extremism based on opinion dynamics, the emergence and development in large fractions of the general public. Our model presents the evolution of initially anti-conformist agents to extreme positions. Numerical analysis shows that there is a large fraction of conformists in the agents of their positions provided that they express the influence parameter controlling the outcome of the dynamics. The uncertainty parameter controlling the outcome of the dynamics is the uncertainty parameter controlling the outcome of the dynamics. Systematic scans of the parameter space show that the conformists uncertainty parameter and the other one following the conformists uncertainty parameter are the only parameters controlling the outcome of the dynamics.

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Social conformity despite individual preferences for distinctiveness

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1. Summary

We demonstrate that individual behaviours directed at the attainment of distinctiveness can in fact produce complete social conformity. We thus offer an unexpected generative mechanism for this central social phenomenon. Specifically, we establish that agents who have fixed needs to be distinct and adapt their positions to achieve distinctiveness goals, can nevertheless self-organize to a limiting state of absolute conformity. This seemingly paradoxical result is deduced formally from a small number of natural assumptions and is then explored at length computationally. Interesting departures from this conformity equilibrium are also possible, including divergence in positions. The effect of extremist minorities on these dynamics is discussed. A simple extension is then introduced, which allows the model to generate and maintain social diversity, including multimodal distinctiveness distributions. The paper contributes formal definitions, analytical deductions and counterintuitive findings to the literature on individual distinctiveness and social conformity.
Further directions
Multiple interacting opinions

The Dissemination of Culture
A MODEL WITH LOCAL CONVERGENCE AND GLOBAL POLARIZATION
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Despite tendencies toward convergence in beliefs, attitudes, and behavior, an agent can exhibit convergent social influence. The actors are hence not locked into a single position, the more likely that the models of social influence or cultural change will account the interaction between different features and possibilities for global polarization. Simulations show that the number of features increases with the number of layers of interaction, and (most surprisingly) decreases with the number of levels of interaction.

Culture and Competition: Homophily and Distancing Explanations for Cultural Niches

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Why do different kinds of people like different kinds of culture? Two answers to this question are formally analyzed and empirically tested: the homophily model and the distancing model. Computer simulation demonstrates that these models are alternative social dynamics for social organization and practice within the context of cultural diversity. Conflicting implications of these models predict that cultural homophily is more likely to decrease or increase the proportion of individuals that choose the same social form, whereas the distancing model predicts that the initial proportion of individuals choosing the same social form, the smaller is the proportion of similar cultural forms. The homophily models predict that cultural homophily is more likely to increase the proportion of similar cultural forms. Instead, it predicts a decrease in cultural homophily.

Layered social influence promotes multiculturality in the Axelrod model

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Despite the presence of increasing pressure towards globalisation, the coexistence of different cultures is a distinctive feature of human societies. However, how multiculturality can emerge in a population of individuals inclined to imitation, and how it remains stable under cultural drift, i.e. the spontaneous fluctuation of traits in the population, still needs to be understood. To solve such a problem, we propose here a microscopic model of culture dissemination which takes into account that, in real social systems, the interactions are organised in various layers corresponding to different interests or topics. We show that the addition of multiplexity in the modeling of our society generates qualitatively novel dynamical behavior, producing a new stable regime of cultural diversity. This finding suggests that the layered organisation of social influence typical of modern societies is the key ingredient to explain why and how multiculturality emerges and thrives in our world.
Small Worlds and Cultural Polarization

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Building on Granovetter’s theory of the “strength of weak ties,” “small-world” networks suggests that bridges between communities (long-range ties) promote cultural diffusion, homogenize cultural settings, and show that this macro-level implication of network structure is consistent with micro-level assumptions. Using a computational model of cultural change, we find that ties between clusters facilitate cultural assimilation and attract cultural diversity. These assumptions also have negative counterparts. When there is homophily, the effect of long-range ties reverses: Even the presence of ties between highly clustered communities sharply increases cultural polarization level.

Paths to Polarization: How Extreme Views, Miscommunication, and Random Chance Drive Opinion Dynamics

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Understanding the social conditions that tend to increase or decrease polarization is important for many reasons. We study a network-structured agent-based model of opinion dynamics, extending a model previously introduced by Flache and Macy (2011), who found that polarization appeared to increase with the introduction of long-range ties but decrease with the number of salient opinions, which they called the population’s “cultural complexity.” We find the following. First, polarization is strongly path dependent and sensitive to stochastic variation. Second, polarization depends strongly on the initial distribution of opinions in the population. In the absence of extremists, polarization may be mitigated. Third, noisy communication can drive a population toward more extreme opinions and even cause acute polarization. Finally, the apparent reduction in polarization under increased “cultural complexity” arises via a particular property of the polarization measurement, under which a population containing a wider diversity of extreme views is deemed less polarized. This work has implications for understanding the population dynamics of beliefs, opinions, and polarization as well as broader implications for the analysis of agent-based models of social phenomena.
Further directions
Scientific beliefs

Persistence of false paradigms in low-power sciences

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We develop a model describing how false paradigms might hinder scientific progress. The model features two paradigms, one describing reality better than the other. Tenure committees display homophily: They favor tenure candidates who are adherents of their paradigm. As in statistics, power is the probability (with no bias) of denying tenure to scientists adhering to the wrong paradigm. The model shows that because of homophily, power is low, the false paradigm may prevail. The model suggests that an increase in power can ignite convergence to the truth. Historical case studies suggest that low power comes not from lack of empirical evidence or from reluctance to base decisions on available evidence.

Do as I Say, Not as I Do, or, Conformity in Scientific Networks

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Abstract

Scientists are generally subject to social pressures, including pressures to conform with others in their communities, that affect achievement of their epistemic goals. Here we analyze a network epistemology model in which agents, all else being equal, prefer to take actions that conform with those of their neighbors. This preference for conformity interacts with the agents’ beliefs about which of two (or more) possible actions yields the better outcome. We find a range of possible outcomes, including stable polarization in belief and action. The model results are sensitive to network structure. In general, though, conformity has a negative effect on a community’s ability to reach accurate consensus about the world.
Next up: Cooperation