

Modeling the evolution of attitude landscapes through opinion dynamics

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with contributions of
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Social Norms, Cultural Transmission, and Attitudes

Social Norm =

Social Consensus in **Attitudes** on a Certain Issue?

Cultural Transmission =

A Slower Version of **Attitude** Change?

Theories of Attitude Change

Social psychologists analyzed the conditions for the *attitude change* of an **individual** when confronted with a **message** from a **source** and derived several theories and effects. E.g.

- ▶ Reinforcement theory
- ▶ Information processing theory
- ▶ Social judgment theory
- ▶ A polarity effect

We want to study the implications of these
on the societal level.

Attitude Framework: An Affective or Evaluative Scale

A 1-dimensional **affective** or **evaluative** scale can represent an individual's . . .

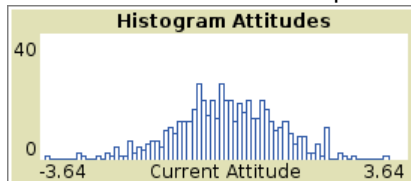
- ▶ Emotional valence towards a person, object, or concept, e.g.
“How good/bad is Trump/Putin/Macron/Merkel?”
“How good/bad are nuclear power plants?”
“How good/bad is religion?”
- ▶ Degree to which a certain value is important
- ▶ Political left—right self-placement
- ▶ Adherence to a norm, e.g. “I would always/never stop at a red traffic light”, “Murder is to be punished with death.”

The Core Questions

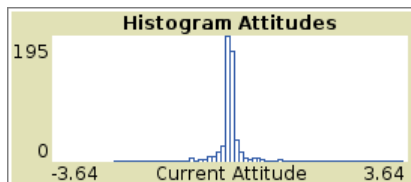
- ▶ How can a collective attitude on one or the other side evolve?
- ▶ How does a moderate consensus evolve?
- ▶ How does a polarized society evolve?
- ▶ How can a society maintain diversity?

More specific

When we start with a normal
initial attitude landscape

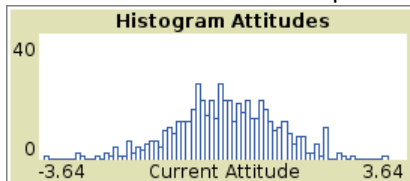


when do we reach
central (neutral) consensus?

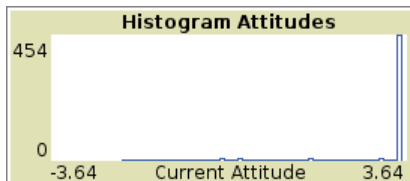


More specific

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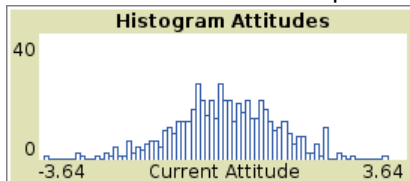


when do we reach
extreme consensus (a clear social norm)?

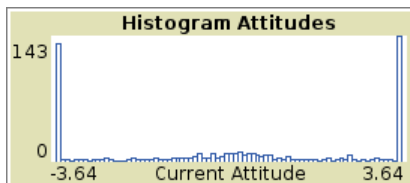


More specific

When we start with a normal
initial attitude landscape

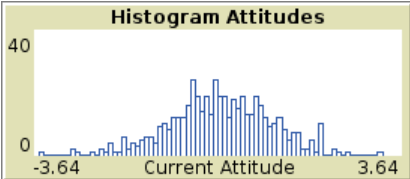


when do we reach
a **polarized** society?

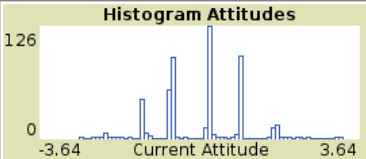
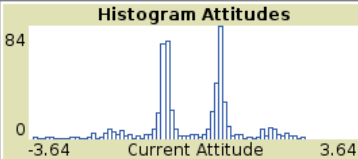


More specific

When we start with a normal initial attitude landscape

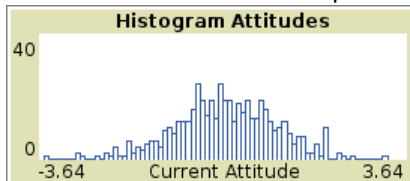


when do we reach **bimodality** or **multimodal fragmentation**?

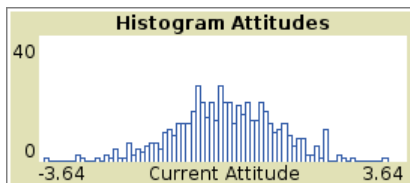


More specific

When we start with a normal
initial attitude landscape

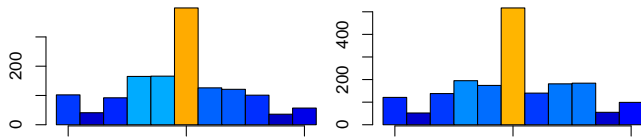


when do we maintain
diversity?

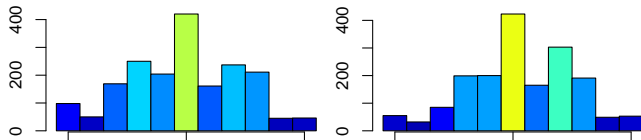


Empirical Example: Left—Right Self-placement

France 2002 and 2012



Sweden 2002 and 2012



Data: European Social Survey (ESS) 2002 to 2012, Questions: "In politics people sometimes talk of 'left' and 'right'. Using this card, where would you place yourself on this scale, where 0 means the left and 10 means the right?"

->

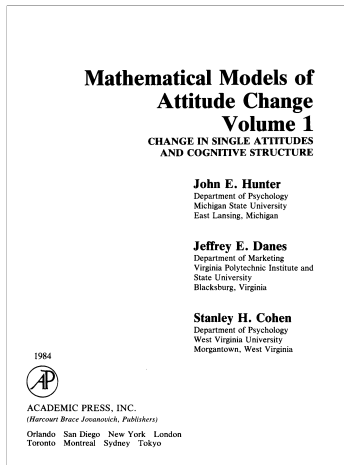
Theories of Attitude Change

Attitude change happens when an **individual** is confronted with a **message** from a **source**. Spectrum of theoretical proposals:

- ▶ **Reinforcement theory** A message triggers change in the direction of the message. (Doob, Katz and Lazarsfeld, Bandura)
- ▶ **Information processing theory** Comparison of own attitude with message leads to a movement towards message. Reduction of attitude discrepancy. (Asch, Hovland)
- ▶ **Social judgment theory** Messages are valued based on discrepancy with respect to a latitude of acceptance. (Sherif)
- ▶ **A polarity effect** Individuals with polar (extreme) attitudes change less. (Hutchinson, Weksel and Hennes)

Formalization

Based mostly on Hunter, Danes and Cohen (1984)



Formalization

$a(t)$ is the *attitude of the receiver towards the object* at time t ,
 $s(t)$ is the *attitude of the receiver towards the source* at time t , and
 $m(t)$ is the *affective or evaluative content of the message* from the
source at time t .

The attitude after the presentation of the message is

$$a(t + 1) = a(t) + \Delta a$$

where Δa is the **attitude change**

$$\Delta a = f(a(t), s(t), m(t)).$$

Society model of attitude dynamics

An individual i changes its attitude as $a_i(t+1) = a_i(t) + \Delta a_i(t)$
where

$$\Delta a_i(t) = f(a_i(t), s(i, j), a_j(t))$$

with j being a randomly selected individual and $s(i, j)$ being the attitude of the receiver i towards the source j .

Initial attitudes are from a normal distribution $a_i(0) \sim \mathcal{N}(0, 1)$.

Individuals may also form independent attitudes. Either new independent attitudes are picked with **probability of independent attitude formation** p , or the initial attitude is reconsidered or weighted in with p .

Continuous opinion dynamics models go back e.g. to Abelson (1964)

Forms of independent opinion dynamics go back to Friedkin and Johnsen (1990) and Pineda, Toral, and Hernandez-Garcia (2009)

The Attitude Change Function

$$\Delta a = f(a, s, m) = \underbrace{\alpha}_{1.} \cdot \underbrace{s(i, j)}_{2.} \cdot \underbrace{(m - \delta a)}_{3.} \cdot \underbrace{\frac{M^b - |a|^b}{M^b}}_{4.} \cdot \underbrace{\frac{\lambda^k}{\lambda^k + |m - a|^k}}_{5.} \cdot \underbrace{\wedge(M - a) \vee (-M - a)}_{6.}$$

1. Strength of change
2. Source credibility
3. Factor specifying the mechanism between reinforcement and information processing
4. Polarity factor
5. Social judgment factor
6. Keep attitude within bounds

The Attitude Change Function

$$\Delta a = f(a, s, m) = \underbrace{\alpha}_{1.} \cdot \underbrace{s}_{2.}$$

1. Strength of change $\alpha \in [0, 1]$
2. Source credibility $s(i, j) \in [0, 1]$

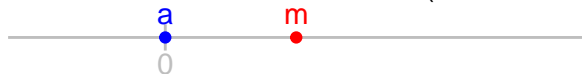
We assign agents to two groups. When i and j are from the same group (intra-group credibility) then $s(i, j) = 1$, when they are from different group (**inter-group credibility**) $s(i, j) \leq 1$

The Attitude Change Function

$$\Delta a = f(a, s, m) = \underbrace{\alpha}_{1.} \cdot \underbrace{s}_{2.} \cdot \underbrace{(m - \delta a)}_{3.}$$

3. Factor specifying the mechanism between reinforcement and information processing

—————→ $\delta = 1$ (information processing)
—————→ $\delta = 0.5$
—————→ $\delta = 0$ (reinforcement)



The Attitude Change Function

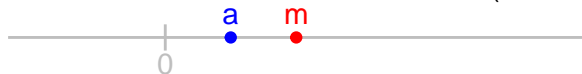
$$\Delta a = f(a, s, m) = \underbrace{\alpha}_{1.} \cdot \underbrace{s}_{2.} \cdot \underbrace{(m - \delta a)}_{3.}$$

3. Factor specifying the mechanism between reinforcement and information processing

————→ $\delta = 1$ (information processing)

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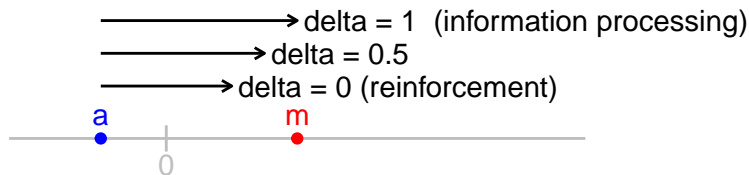
————→ $\delta = 0$ (reinforcement)



The Attitude Change Function

$$\Delta a = f(a, s, m) = \underbrace{\alpha}_{1.} \cdot \underbrace{s}_{2.} \cdot \underbrace{(m - \delta a)}_{3.}$$

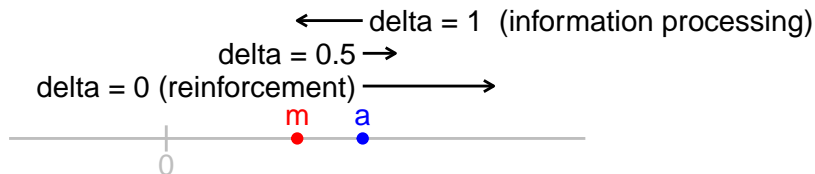
3. Factor specifying the mechanism between reinforcement and information processing



The Attitude Change Function

$$\Delta a = f(a, s, m) = \underbrace{\alpha}_{1.} \cdot \underbrace{s}_{2.} \cdot \underbrace{(m - \delta a)}_{3.}$$

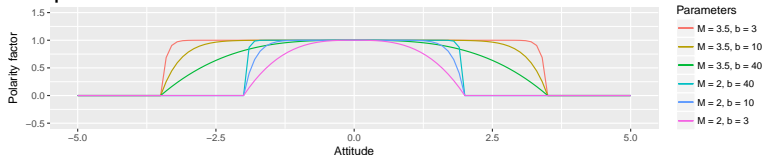
3. Factor specifying the mechanism between reinforcement and information processing



The Attitude Change Function

$$\Delta a = f(a, s, m) = \underbrace{\alpha}_{1.} \cdot \underbrace{s}_{2.} \cdot \underbrace{(m - \delta a)}_{3.} \cdot \underbrace{\frac{M^b - |a|^b}{M^b}}_{4.}$$

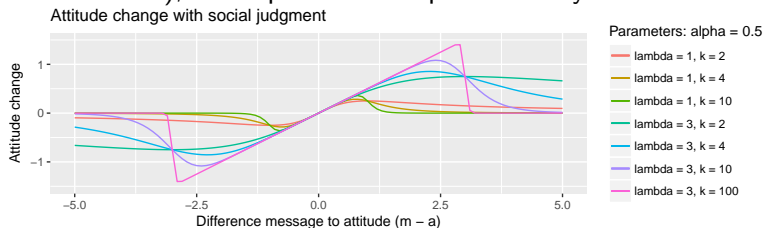
4. Polarity factor. M maximal/minimal attitude, b polarity sharpness



The Attitude Change Function

$$\Delta a = f(a, s, m) = \underbrace{\alpha}_{1.} \cdot \underbrace{s}_{2.} \cdot \underbrace{(m - \delta a)}_{3.} \cdot \underbrace{\frac{M^b - |a|^b}{M^b}}_{4.} \cdot \underbrace{\frac{\lambda^k}{\lambda^k + |m - a|^k}}_{5.}$$

5. Social judgment factor. λ latitude of acceptance (aka bound of confidence), k sharpness of acceptance decay



The Attitude Change Function

$$\Delta a = f(a, s, m) = \underbrace{\alpha}_{1.} \cdot \underbrace{s}_{2.} \cdot \underbrace{(m - \delta a)}_{3.} \cdot \underbrace{\frac{M^b - |a|^b}{M^b}}_{4.} \cdot \underbrace{\frac{\lambda^k}{\lambda^k + |m - a|^k}}_{5.} \underbrace{\wedge(M - a) \vee (-M - a)}_{6.}$$

6. Keep attitude within bounds

Every attitude exceeding the bounds are set to the bound

Simulation in NetLogo (Wilensky, 1999)

A. Attitude dynamics

A. Parameters

1. Basic parameters

- N: 500
- independent_distribution: normal (mean 0 sd 1)
- initial_groups...: 0.00
- p: 0.005
- p_as: probability for new random

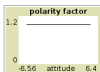
2. Attitude change parameters

- alpha: 0.10
- intergroup credibility: 1.00

reinforcement: delta 1.00 information processing

polarity

- M: 3.5
- b: 100



Social judgment

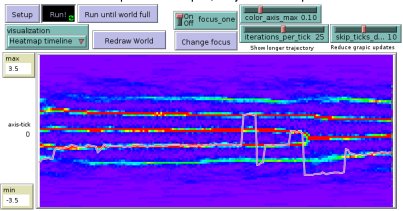
- social judgment: social judgment
- lambda: 0.400
- k: 95



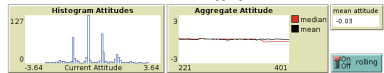
Click to play with parameters before run:

Update Plots

B. Time evolution of opinion landscapes / Trajectories of opinions



C. Monitors of attitude distribution and aggregate attitudes over time



D. Examples

Central Consensus: information processing + group spread and low credibility + polarity + smooth social judgment

Extreme Consensus: reinforcement + group spread + low credibility + turnover mixed information processing with polar...

Polarization: reinforcement no credibility + group spread, low credibility reinforcement social judgement

Multimodality: information processing group spread low credibility turnover sharp social judgment + turnover + some reinforcement

Maintain Diversity: Reinforcement Turnover 0.1 Strength 0.1 Turnover 0.05 Strength 0.2 Speed up 25 times!

Answers: Central (Neutral) Consensus

evolves with

- ▶ Information processing
 - ▶ even with initial group spread
 - ▶ even with low intergroup credibility
 - ▶ even with narrow latitudes of acceptance and smooth social judgment

Abelson's (1964) lament:

What on earth one must assume in order to generate the bimodal outcome of community cleavage studies.

Answers: Extreme Consensus (Clear Social Norm)

evolves with

- ▶ Reinforcement
 - ▶ even with initial group spread
 - ▶ even with fairly low intergroup credibility
- ▶ Information processing with polarity
Mechanism: Small imbalance in initially extreme individuals, one side attracts more

Answers: Polarized Society

evolves with

- ▶ Reinforcement with no intergroup credibility (50 % chance)
- ▶ Reinforcement with initial group spread even under with some intergroup credibility
- ▶ Reinforcement with social judgment (even smooth with large latitude of acceptance)

No **repulsive forces** (aka boomerang effects) needed to create polarization!

Answers: Bimodality and Fragmentation

evolve with

- ▶ Bimodality (mild form of polarization):
 - ▶ Information processing with initial group spread, low intergroup credibility, and turnover
- ▶ Fractionalization (3, 4, ... modes):
 - ▶ Information processing with moderate or small latitudes of acceptance and **sharp** social judgment (aka bounded confidence)
- ▶ With mild turnover LONG-TERM dynamics appear:
 - ▶ Information processing: **Inward** joining of clusters, extremal emergence of clusters
 - ▶ Mixed model (mild reinforcement): **Outward** drift of clusters, central emergence of clusters

Answers: Maintain Diversity

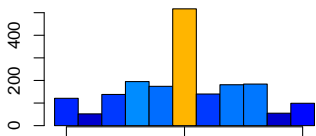
is possible with

- ▶ Sufficient amount of turnover / inflow of independent attitudes (various types possible)
 - ▶ It seems that **critical values** exist
 - ▶ This shows us the thresholds needed to trigger the potential for a shift in extreme consensus.

Conclusion

Next steps

- ▶ Heterogeneous individual parameters, mixed populations:
 - ▶ open-minded and closed minded agents (heterogeneity of λ)
 - ▶ reinforcers and information processors (heterogeneity of δ)
 - ▶ different amount of independent attitude formation (heterogeneity of p)
- ▶ Can we reproduce such landscapes?



Can we predict further evolution?

- ▶ Thank you for your attention!

