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Agent-based modeling for modular theory comparison

Keywords: Agent-based models, social theory, polarization, ideology, identity

Extended Abstract

Agent-based models shorten the interpretive gap between social phenomena and social theory by allowing a researcher to encode their theory into a simulation, generate data, and compare it to empirical data [4, 2]. The viability of theories no longer must be measured by the motivated reasoning of their proponents but by the distance between simulations and observations. Much work has already been done to fit models to empirical data [3, 5]. However, an under explored benefit of agent-based models is their ability to modularize social theories and compare components independently. Deconstructing theories to their component mechanisms and simulating the impacts of small modifications could lead to more precise debates that can be empirically grounded.

In this study, I provide an illustrative example of how we can use the modularity of agent-based models to compare component mechanisms of affective and ideological polarization. In particular, I modify the local interaction behavior in the Attraction-Repulsion model (ARM) of ideological polarization by Axelrod et al. [1] to reflect in-group assimilation and out-group differentiation while maintaining ideological homophily.

I made the below change to the equations that define the assimilation and differentiation behaviors of agents i and j where their ideological difference $d = I_j - I_i$, $\mathbf{T}$ is the agent's tolerance, $\mathbf{R}$ is the agent's responsivenss, $\mathbf{G}$ is the agent's group identity, and ΔI_i is the agent's change in ideology due to the interaction:

$$\Delta \mathbf{I}_i = \begin{cases} |d| \leq \mathbf{T}_i & \mathbf{R}_i \cdot d \\ |d| > \mathbf{T}_i & -\mathbf{R}_i \cdot d \end{cases} \quad \rightarrow \quad \Delta \mathbf{I}_i = \begin{cases} \mathbf{G}_i = \mathbf{G}_j & \frac{1}{3}\mathbf{R}_i \cdot \dfrac{|d|}{d} \\ \mathbf{G}_i \neq \mathbf{G}_j & -\frac{2}{3}\mathbf{R}_i \cdot \dfrac{|d|(1-\mathbf{T}_i)}{d} \end{cases}$$

There are three key findings from this comparison so far. First, the affective model never converges to a central position while the ideological one can (see Figure 1). Second, tolerance is an important parameter for determining the dynamics of the original ARM model but not the affective variant (see Figure 2). Thirdly, the combination of ideological homophily and affective assimilation/differentiation mechanisms can result in the same group being ideologically split if they mostly interact with agents in their out-group (see Figure 3).

Future work will be done to fit each of these models to real data to see which can reproduce realistic dynamics. Additionally, modifications will be made to compare ideological homophily to affective homophily while holding the assimilation/differentiation mechanism constant.

This study was not meant to provide any conclusive evidence for affective or ideological polarization but as an example for how more specific comparisons can be made between alternative social theories using agent-based models. It's clear that this approach can reveal surprising dynamics and differences when swapping out component mechanisms.

References

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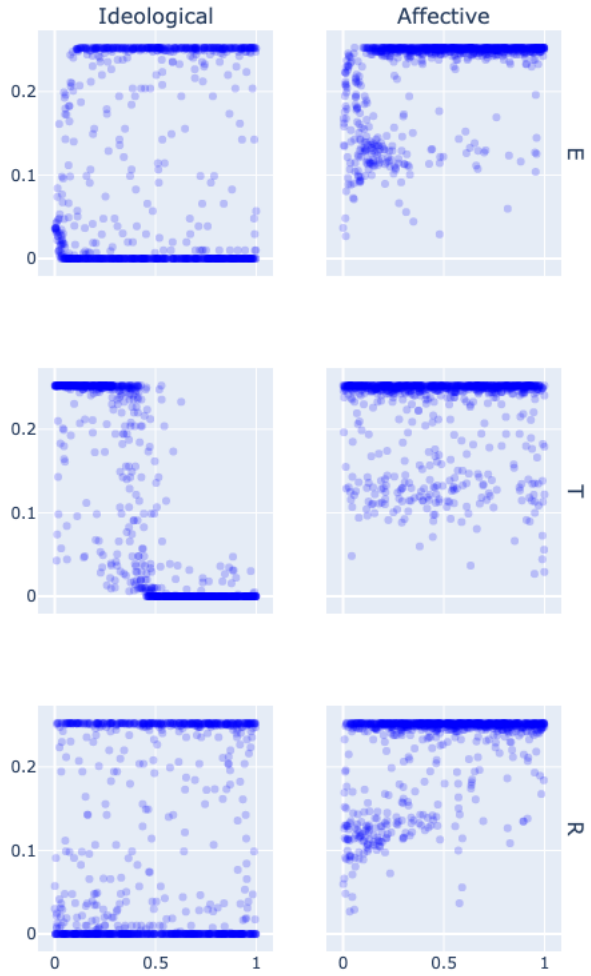

Figure 1: Comparing the ARM models by ordering 1000 randomly parameterized runs. The x-axis is the parameter value identified on the right of each row and the y-axis is the polarization after 250,000 steps measured by the variance of $\mathbf{I}_i$ for all agents.

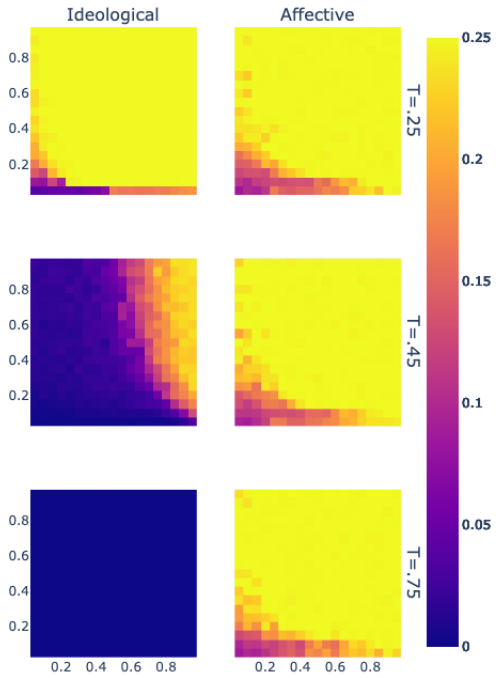

Figure 2: These are polarization heatmaps comparing **E** (y-axis) with **R** (x-axis) for different values of **T**. Each square represents the average polarization of 10 runs after 250,000 steps.

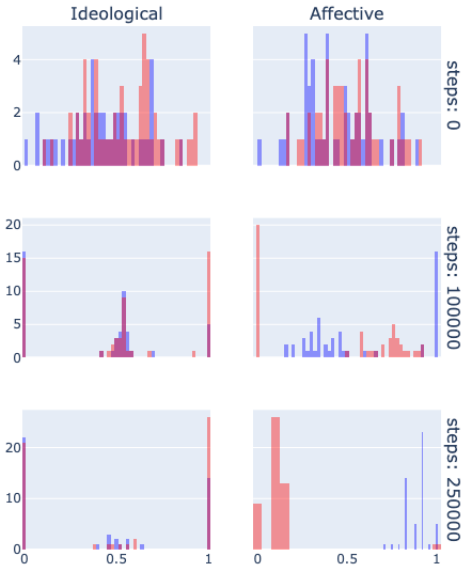

Figure 3: This compares a run of the ideological and affective models with the parameterization $\mathbf{E} = .1$, $\mathbf{T} = .25$, and $\mathbf{R} = .25$. Each plot is a histogram of the ideological distribution after a certain number of steps identified on the right side of each row, colored by group.