Simulator Explanations – Academic Version (October 2025)

This updated explanatory document integrates all conceptual and functional changes introduced between September and October 2025. It presents the theoretical foundations of the model, the key behavioral parameters, and the advanced features related to the reward system, meme dynamics, meta-influencer behavior, and probabilistic limitation of external events.

1. General Introduction

The simulator models the diffusion and transformation of opinions within a networked population of agents. Each agent possesses an opinion, a prevalence (interpreted as cognitive salience), and a level of influence. Interactions occur across dynamic networks where opinions evolve through imitation, reinforcement, and local feedback. The model is inspired by the framework of Complex Adaptive Systems (Holland, 1995; Epstein & Axtell, 1996) and builds on work in opinion dynamics (Deffuant et al., 2000), distributed cognition, and cultural transmission (Sperber, 1996; Boyd & Richerson, 2005).

The model introduces several interdependent dimensions: group alignment, memetic representation, the stabilizing role of meta-influencers, and reinforcement-based social learning. External events can trigger perturbations that reshape both the distribution of opinions and the cognitive prevalence of agents.

2. Core Dynamics

Agents evolve along a continuous opinion scale ranging from -1 (negative polarity) to +1 (positive polarity). Prevalence represents the strength or number of internal representations supporting that opinion. Each iteration (tick) simulates random pairwise interactions within the agent network. The probability of opinion adoption depends on the difference in prevalence, influence level, opinion proximity, and group alignment. Network connections adapt dynamically, forming or breaking based on ideological similarity and exposure to disagreement.

3. Reward System

The reward system introduces a dynamic mechanism of social reinforcement. When an agent successfully influences a neighbor (i.e., the target agent changes its opinion), it receives a temporary influence bonus (tx-bonus). This bonus increases the probability of success in future interactions, simulating the consolidation of symbolic capital, prestige, or charisma. The reward-step parameter determines the increment size of the bonus, while reward-cap defines the upper limit. Reward-decay controls the gradual loss of influence over time, representing social forgetting or reputation erosion.

Example: Setting reward-step to 0.1 and reward-cap to 0.5 creates a system where repeated success consolidates leadership, illustrating the rise of opinion leaders or influencers in a polarized environment.

4. Meme Dynamics

When the switch use-memes? is activated, the simulator transforms opinion dynamics into a memetic process. Each agent holds two memetic reservoirs: meme-plus (supporting its opinion) and meme-minus (opposing it). The sum of these reservoirs determines cognitive prevalence, while their difference defines opinion polarity. During interactions, memes are exchanged: agents aligned with the sender reinforce coherent memes, while contradictory memes leak according to the meme-anti-leak parameter.

Example: With meme-anti-leak = 0.2, agents partially lose inconsistent memes during interactions, reproducing cognitive reinforcement mechanisms and echo-chamber effects.

5. Meta-influencers and Metablock

Meta-influencers (yellow agents) represent dominant actors—media hubs, institutional voices, or political elites. When metablock is set to true, meta-influencers cannot switch opinion polarity: they may reinforce their stance but never adopt the opposite sign. This models ideological rigidity or institutional inertia often found in hierarchical systems.

Example: In political simulations, metablock=true allows for the modeling of persistent ideological centers, such as stable party alignments despite societal change.

6. External Events and Probabilistic Limitation

The parameter event-prob-max (range: 0.00–1.00; default: 1.00) defines the maximum fraction of agents that may be affected by an external event. When an event is triggered—either manually (event button) or automatically (auto_event)—each agent draws a random value $u \in [0,1]$. If $u \leq$ event-prob-max, the agent undergoes the event's logic: a change in opinion (event_size), an optional variation in prevalence (prev_change), and checks for thresholds (low_meme–high_meme, low-prev–high-prev).

• 1.00 (100%): global shock – system-wide transformation such as a revolution or pandemic.
• 0.10 (10%): partial shock – regional or media-driven disturbances.
• 0.01 (1%): micro-level perturbations – interpersonal influence or rumor diffusion.

7. Applications and Research Contexts

This simulator supports multi-level exploration of social cognition and network evolution. It can be applied to the study of political polarization, diffusion of innovation, rumor propagation, or collective learning dynamics. The flexibility of parameters like group-impact-weight, reward-step, meme-anti-leak, and event-prob-max allows researchers to formulate and test hypotheses grounded in cognitive science, social psychology, and complexity theory.