Noise and opinion dynamics: How ambiguity promotes pro-majority consensus in the presence of confirmation bias

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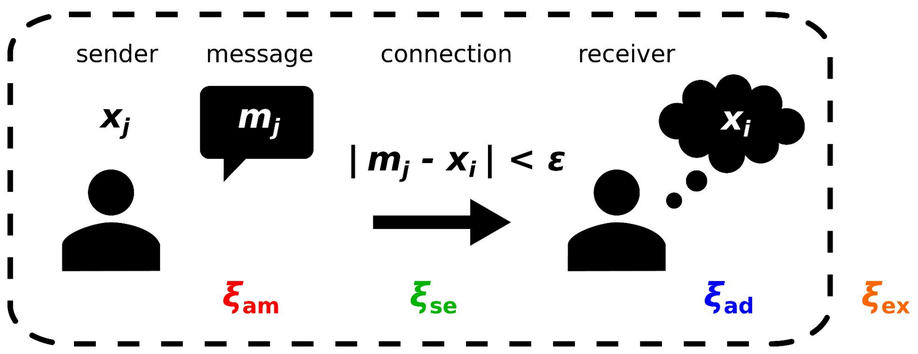
Introduction

Social influence plays a critical role in how people form opinions. But it is affected by biases and noise. The role of biases has been studied extensively, but the role of noise is less clear. Noise is a source of stochasticity, but it can capture a variety of real-world processes, which can all be formalised in different ways. Yet, there has been little effort to systematically and comprehensively compare the different types of noise and their effects on opinion patterns. Here, we present an ABM of opinion formation in which agents are affected by confirmation bias (conceptualised as bounded confidence) and different types of noise during social influence.

Different types of noise in the bounded confidence model



How different types of noise act inside or outside of the social interaction process.

The model of opinion formation with opinions, x_i in *[0,1]*, noise, ξ, and bounded confidence, ε, representing the confirmation bias. Noise is drawn from a zero-mean normal distribution with noise strength ν such that opinions or messages remain within the bounds of the belief space *[0,1]*.

Previously studied types of noise:

1. **selection noise, ξ_{se}**, affects whether a receiver is chosen for interaction in light of the difference between message and receiver opinion and the confidence bound
2. **adaptation noise, ξ_{ad}**, affects the receiver's opinion after an interaction
3. **exogenous noise, ξ_{ex}**, perturbs an agent opinion from outside of the social interaction

Not studied so far:

4. **ambiguity noise, ξ_{am}**, acts on the message from a sender

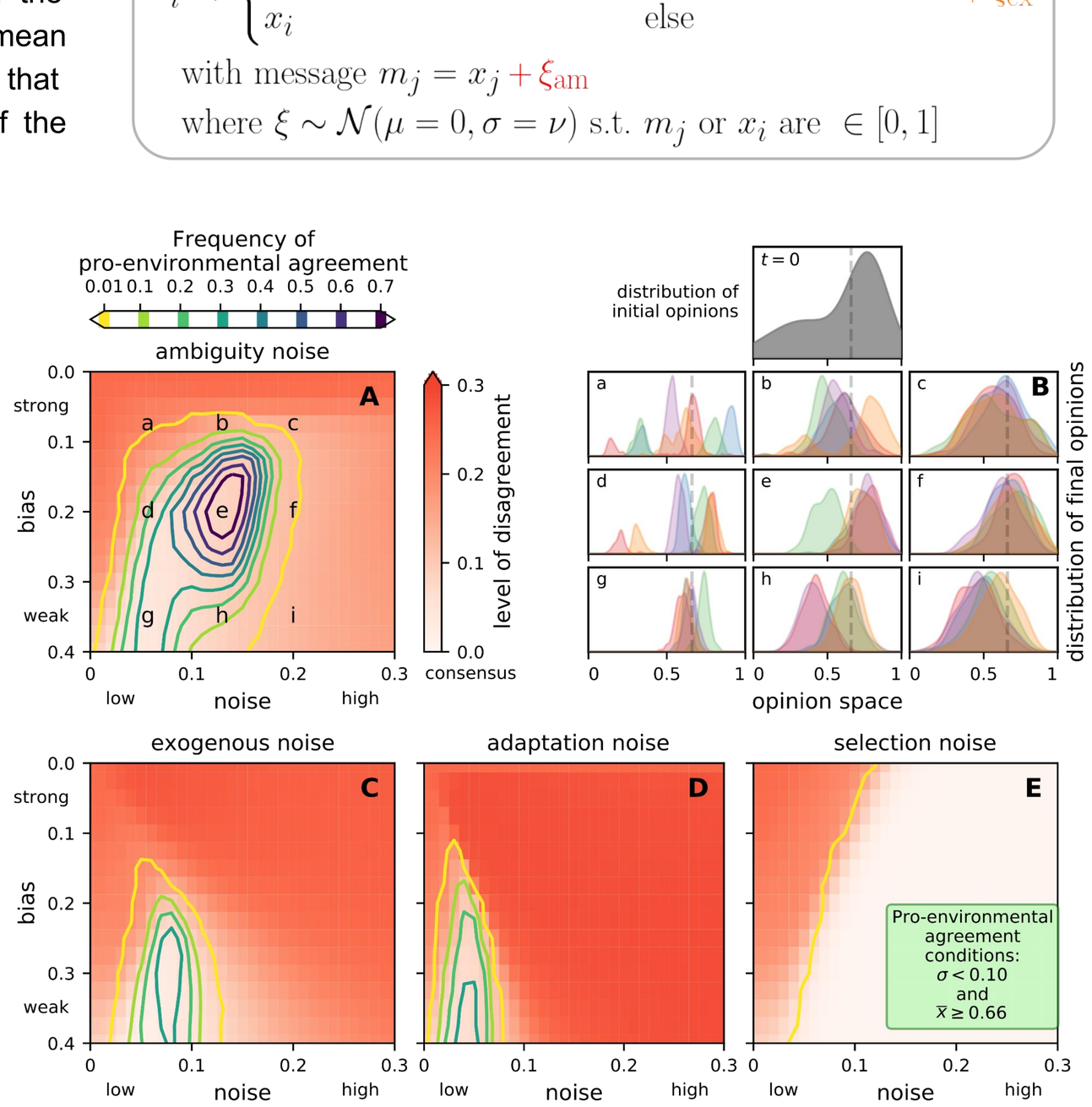
$$x_i \mapsto \begin{cases} x_i + \mu \cdot (m_j - x_i) + \xi_{\text{ad}} & \text{if } |x_i - m_j| \leq \epsilon + \xi_{\text{se}} \\ x_i & \text{else} \end{cases} + \xi_{\text{ex}}$$
$$\text{with message } m_j = x_j + \xi_{\text{am}}$$
$$\text{where } \xi \sim \mathcal{N}(\mu = 0, \sigma = \nu) \text{ s.t. } m_j \text{ or } x_i \text{ are } \in [0, 1]$$

Simulations and Results

We focus on the novel **ambiguity noise** as it plays a crucial role in social influence dynamics (see the `crowd-within' effect and the literature on strategic ambiguity), especially for a complex topic like **climate change**, which is prone to create misunderstandings and interpretation errors during communication or social influence.

The initial opinions x_i are based on empirical data about climate change attitudes (the `six Americas', see Maibach et al., 2011).

We measure (1) the **level of disagreement** among agents as the standard deviation of all opinions and (2) **how frequently a society reaches a pro-environmental agreement**, defined as low disagreement and high average climate change opinion.



Result 1: Bias and ambiguity noise foster pro-environmental agreement.

For ambiguity noise, moderate noise induces agreement (panel A) and group drift under moderate levels of bias (panel B–e). Overall, it is this combination of bias and ambiguity noise that promotes pro-environmental agreement.

Result 2: The other types of noise induce different opinion patterns and much lower levels of pro-environmental agreement.

With exogenous noise (C) and adaptation noise (D), the window in which noise fosters agreement shrinks with increasing bias, thus promoting disagreement. With selection noise (E), moderate noise induces agreement, but this is only reached by compromising on moderate opinions.

Preprint:
Steiglechner, P., Keijzer, M. A., Smaldino, P. E., Moser, D., & Merico, A. (2023). Noise and opinion dynamics: How ambiguity promotes pro-majority consensus in the presence of confirmation bias. https://doi.org/10.31235/osf.io/u2t7r

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