Noise as a Key Factor in Realizing a Creative Society

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Abstract

To achieve a creative society, it is important to maintain a diversity of values. However, due to automatic alignment of values, maintaining diverse values is a challenge. We propose that the noise, i.e, the uncertainty in understanding others' values, may play a key role in realizing a creative society by moderating values alignment. In addition, the potential effects of noise may be affected by the social perception bias at the societal level. To study the dynamics of values diversity resulting from peer interactions with noise and perception bias, we present a hybrid opinion dynamics model, in which values is represented as both continuous and discrete categories. We simulate online social networking with various levels of noise and perception bias. We found that the positive effects of noise are twofold: it helps to moderate the alignment process of values within a group and to improve the social inclusiveness of extremism views. We conclude that noise contributes to preventing social fragmentation and monolithicization, and therefore plays a key role in realizing a creative society.

Introduction

A vision of the future of our society is the "Creative Society", in which the co-creation, instead of economy, is considered to be the core of the social systems (Iba 2016). Co-creation is a creative activity that requires collaboration between multiple individuals. Previous researchers noted that including members with diverse backgrounds in creative activities can create a more inclusive atmosphere and lead to better outcomes (Mannix and Neale 2005; Hawlina, Gillespie, and Zittoun 2019). At the societal level, maintaining a diversity of values (i.e., ideological beliefs such as conservative/liberal) could also create an inclusive social atmosphere and benefit social co-creation. Therefore, maintaining diverse values can facilitate the realization of a creative society.

Meanwhile, maintaining diverse values is a challenge due to social alignment. In social-cognitive science, social alignment refers to the alignment of minds and bodies in social interaction (Gallotti, Fairhurst, and Frith 2017), which can be an automatic and unconscious process (Chartrand and Bargh 1999). When understand others' values, unconscious alignment of values may occur, negatively affecting the diversity of values.

We propose that one effective factor that can counteract the negative effects of social alignment is the noise, i.e., the uncertainty, when understanding the values of others. In a modern society, we understand others' values mainly through their messages posted on online social networks sites (SNS). Usually, the noise is considered negative, as it can produce misunderstanding and cause severe problems in many cases. Hence, a goal of technology development (e.g., annotation, labeling) is to reduce the influence of noise (Souri, Hosseinpour, and Rahmani 2018). However, too low noise may strengthen the values alignment and thus have negative impacts on realizing a creative society.

This study aims to clarify the potential role of noise in maintaining diverse values. We hypothesize that the role of noise is affected by the societal level of social perception bias. Social perception bias refers to one's bias when perceiving the values of others, which can have different directions related to social categorization (e.g., distinguishing between *ingroup* and *outgroup* (Brewer 1999)). The societal level of such a bias could be considered as a distinguishing characteristics varied by culture and society. In a society with high-level social perception bias, the understanding of others is more easily biased by the perceiver's own values. Social perception bias can affect the understanding of others' values and therefore can play a role in the alignment of values.

This work focuses on the potential effects of online social networking on the alignment of values. We followed the KISS (Keep It Simple, Stupid) principle to study computational social creativity (Saunders and Bown 2015). We developed a multi-agent model for modeling online social networking and the alignment of values in societies with various bias levels. In our model, each agent has its values, represented in a hybrid way, i.e., as both a continuous numerical value and a discrete category (e.g., Leftism/Centrism/Rightism in politics, Centralization/Neutral/Localism in digital products/services). The agents are uniformly distributed in a virtual space and read messages posted by their neighbours who have similar service networking preferences (e.g., the frequency of using specific social networking sites). By reading a message, an agent perceives the values of the message poster and may adjust its own values accordingly. We modeled the values with well-established categories and remains stable at the individual level (e.g., individual attitudes towards certain policy issues (Carsey and Layman 2006)), which is consistent with the social intuitionist view (Haidt 2001). Hence, the social alignment is bounded, i.e., an agent only align its own values within the same category and thus always stick to that category.

We simulated online social networking under different levels of noise, which is related to the development of information technology. We analyzed the dynamics of values diversity and discussed potential role of noise.

Model

This work presents an opinion dynamics (OD) model, which are agent-based models adapted from physics to study the formation of opinions or beliefs. We used a hybrid design, i.e., the opinions are represented in both discrete and continuous ways, similar to the three-state CODA (Continuous Opinions and Discrete Actions) model (Martins 2010). To better reflect the nature of social values, we made two major changes. First, the agents in the CODA model perceive others' opinions as discrete numbers, while we use a continuous design. Second, the updates of the opinions is bounded by the agents' initial value categories. The fixed-category design enables the study on the interactions between groups with well-established opinion categories.

In our model, multiple agents are aligned in 1-dimension space, which is the simplest case of uniformly distributed social networks. The position of agents is fixed during the simulation. Each agent has an opinion about the sense of values. For an agent i, its values is represented as both a continuous numerical value v_i and a discrete category o_i. The v_i is represented as a real number within the interval $(0, 1)$. The o_i is represented as an element in the finite set $\{1, 2, 3\}$, corresponding to three positions of values: the two ends of the spectrum (i.e., $v_i \leq 1/3$ and $v_i > 2/3$) and the neutral position (i.e., $1/3 < v_i \leq 2/3$). The category o_i is fixed in a simulation.

At each time step, every agent reads a message posted by a random neighbor within a distance L, which represents the differences in their social networking preferences. We set $L = 20$ in this work. As we use a 1-dimension setting, this setting means that an agent can see the posts made by 20 other agents with closest social networking preferences.

When the agent i reads a message by the neighbor j, the values of j is perceived by i as both a numerical value v'_j and a category o'_j. The v'_j is computed first, and then the o'_j is set accordingly. The v'_j is a random value following the uniform distribution within the interval D_{ij}, which is determined by the true value (v_j), the noise level (B), and the perceiver's bias towards the poster j (δ_{ij}):

$$D_{ij} = (v_j - B + \delta_{ij}, v_j + B + \delta_{ij}) \tag{1}$$

The parameter B is a variable within the interval $(0, 0.5)$, which produces a random offset from the true value. The setting of $B > 0$ corresponds to inevitable noise in the understanding of others. When $B \geq 0.5$, the values corresponding to the neutral position 0.5 would be perceived as any values in the whole space $[0, 1]$.

The perceiver bias produces a biased offset from the true value, which is related to the distance between the values v_i and v_j:

$$\delta_{ij} = \begin{cases} |v_i - v_j|^{1/k} & \text{if } v_i - v_j < -\lambda, \\ & \text{or } 0 \leq v_i - v_j < \lambda \\ -|v_i - v_j|^{1/k} & \text{if } -\lambda \leq v_i - v_j < 0, \\ & \text{or } \lambda \leq v_i - v_j \end{cases} \tag{2}$$

, where the λ is a threshold for determining the bias direction, and k represents the societal level of social perception bias. The threshold λ represents the boundary between *ingroup* and *outgroup* categorization (see Figure 1, the dashed line). When the distance between v_i and v_j is smaller than λ (on the left of the dashed line), v'_j tends to be similar to v_i. Otherwise, v'_j tends to be different from v_i. In this study, we set $\lambda = 0.5$, which corresponds to a balanced categorization when the regions of inclusions and exclusions are symmetrical.

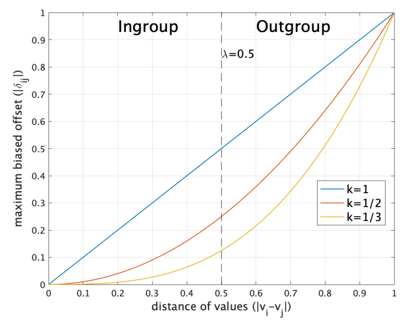

Figure 1: The effect of the bias level k. Dashed line shows the threshold λ.

The parameter k is a variable within the interval $(0, 1)$, which determines the relationship between the values differences and the biased offset (see Figure 1). A smaller k corresponds to a society where the understanding of others is less susceptible to the perceiver's own values.

Following the computation of v'_j and o'_j, if the message poster j appears to belonging to the same category as the perceiver i, i.e., $o_i = o'_j$, i would adjust its values to align with j. First, the numerical value at the time step t is computed as:

$$v_i(t + 1) = v_i(t) - \mu(v_i(t) - v'_j(t)) \tag{3}$$

, where μ defines the speed of alignment, which is set to 0.3 (a moderate speed) in this study. The updates of v_i follows a bounded design, i.e., i will do nothing if $o_i \neq o'_j$. Hence, i will never change the category o_i, and the numerical value v_i will be kept within the boundary of the initial category.

Simulation Results

Using the proposed model, we run simulations with various settings of noise level (B) and bias level (k). In all runs, the number of agents (N) was 3000, which were divided equally into three groups (Group A, B, and C). At the beginning of each run, for the agents in Group A, B, and C, the initial category (o_x) was fixed to 1, 2, and 3, respectively, while the initial numerical value (v_x) was set to random numbers following a uniform distribution in the interval $(0, 1/3)$, $(1/3, 2/3)$, and $(2/3, 1)$, respectively.

A qualitative analysis is performed to examine potential effects of noise on the society behavior at low- and high-level of bias. We found that low noise affects the behavior of low- ($k = 0.33$) and high-biased ($k = 0.90$) societies in different ways. The changes of population histogram in typical runs at various noise levels (0.01, 0.05, 0.10, and 0.30) are plotted in Figure 2 and Figure 3, corresponding to the low- and high-level bias settings, respectively.

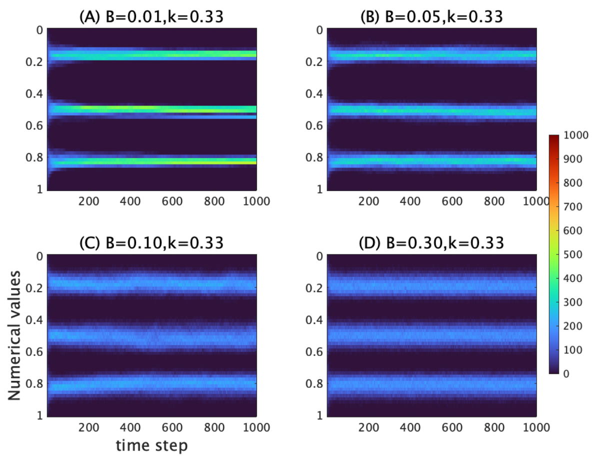

Figure 2: Changes of population histogram in typical low bias ($k = 0.33$) runs. Four panels corresponds to various noise levels (B). Color bar indicates the population.

At the low bias level, a decrease in noise level leads to a convergence of each group's values toward the center of respective groups. At the high bias level, the results are different among groups. For the extremism groups (Group A and C), a decrease in noise level did not only lead to a convergence of values towards the group center, but also bring the distance between extremism groups closer and thus result in a narrower range of values. For the centrism group (Group B), however, diverse values could be observed at low noise levels.

In the quantitative analysis, we first analyzed the overall diversity of values by computing the Shannon Index (e) of the numerical value (v_x) for the whole population in the society. To compute e, we divided the interval $(0, 1)$ into 50 equal-width segments. Then the Shannon Index at the time step t was computed as:

$$e(t) = -\sum_{i=1}^{S} p_i(t) \log(p_i(t)) \quad (4)$$

, where S is the segments space covering $(0, 1)$, and p_i is the number of agents who held values with a numerical value within each segment.

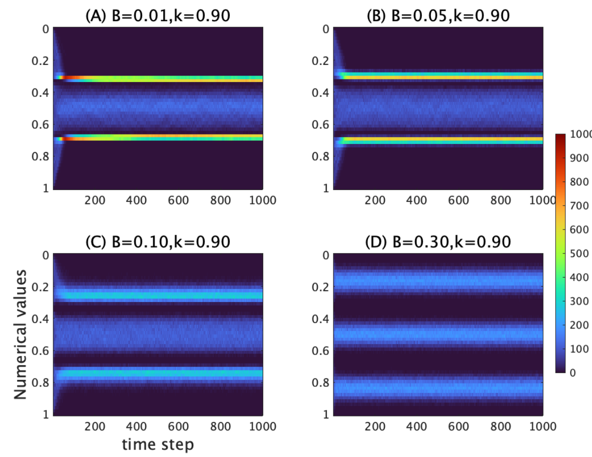

Figure 3: Changes of population histogram in typical high bias ($k = 0.90$) runs. Four panels corresponds to various noise levels (B). Color bar indicates the population.

Each run lasted for 1000 time steps. As showed in the results from typical runs, this setting is sufficient for the society to reach a stable state. We measured the final diversity in a run by the Shannon Index at the final step. We analyzed the averaged results of 30 runs.

For a low-level bias and a high-level bias settings, the overall diversity in relation to the noise level is plotted in Figure 4 *Left*. Within each group, the relationship between noise level and local diversity of values is plotted in Figure 4 *Middle*. At various noise levels, the effects of noise on the range of values (measured by the standard deviation) is plotted in Figure 4 *Right*.

Despite minor differences, the negative effects of low noise on the overall diversity did not differ noticeably in both magnitude and trend. In contrast, there is a difference in the noise effects on local diversity of values under different settings. At a low-level bias setting, low noise negatively affected local diversity in all three groups equally. At a high-level bias setting, the negative effects of low noise on local diversity in the extremism groups (Group A and C) was more drastic. For the centrism group (Group B), however, lowering noise could lead to a dramatic increase in the local diversity of values. Meanwhile, we also found a difference in the noise effects on the values range under different settings. At a low-level bias setting, low noise had little effects on the standard deviation of values. That is, at various noise levels, the range of values was maintained. At a high-level bias setting, lowering noise resulted in a decrease in the standard deviation of values. That is, the range of values became narrower at low levels of noise.

Discussion

In general, our results suggest that, regardless of the societal level of social perception bias, a certain degree of noise (i.e., uncertainty) when understanding others' values through online social networking is necessary for maintaining the di-

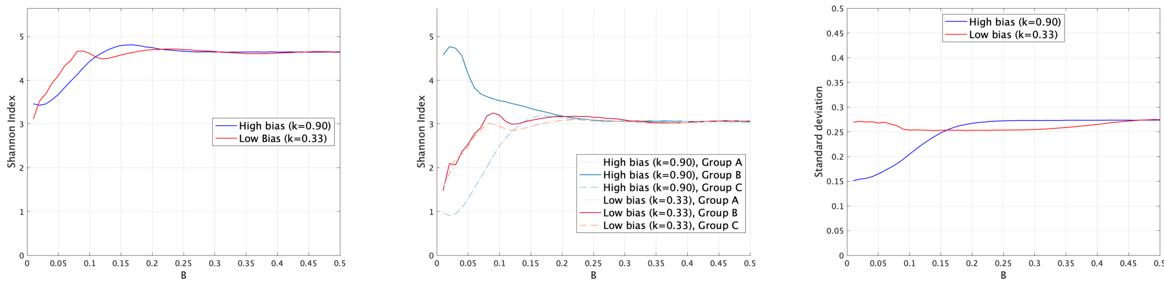

Figure 4: *Left*: Overall values diversity at different noise levels (B) under low- and high-level bias (k) settings. *Middle*: Local values diversity in each group in relation to noise (B) at low- and high-level bias (k). *Right*: Standard deviation of values in relation to noise (B) at low- and high-level bias (k).

versity of values, which is a key to achieving a creative society. Moreover, depending on the bias level of social perception in a society, the mechanism underlying the observed effect of noise may vary.

In societies with low levels of bias, there are fewer categorization errors caused by perceiver bias (see Figure 1). Values alignment occurs mainly within a group, while interactions between different groups are suppressed. In this case, low levels of noise can strengthen social fragmentation (see Figure 2). Thus, when the bias level of social perceiving is low, noise may be necessary for maintaining the overall values diversity by influencing the values alignment within a group, i.e., by maintaining local diversity of values.

For societies with high bias levels, since the perceiver's own values have a greater impact on the understanding of values, neighboring groups can influence each other. The alignment of values occurs not only within the groups, but also between the centrism groups and the groups on the two ends of the spectrum. This result is consistent with previous findings on the attraction from moderate opinions in the three-option CODA model (Martins 2010). We found that the inter-group attraction is strengthened at high bias level. Thus, a low level of noise can strengthen the social monolith (see Figure 3).

In a low-noise condition, the alignment of values reduces the internal diversity of the extremism groups. However, probably, for the centrism group, the effect of alignment can be counteracted by the attraction between neighboring groups, which could even lead to an increase in local diversity. Meanwhile, the attraction strengthened by low-noise leads to the convergence of the extremism groups toward the centrism group, thus narrowing the range of values. Therefore, when the bias level is high, noise not only affects the alignment process of values within groups, but also affects the interactions between neighboring groups, thus contributes to the overall diversity of values.

Our definition of noise and bias is compatible with the concepts proposed recently by Kahneman, Sibony, and Sunstein (2021). In their work, the noise in social perception was considered a "flaw" that should be reduced as much as possible. In contrast, this study shows that noise can effectively reduce the negative effects of social alignment on diversity of values, thus contributing to a more inclusive social atmosphere and facilitating the realization of a creative society. In particular, our results suggest that noise is more important for societies with high bias levels of social perception. In a high biased society, values alignment is more likely to occur, thus creating a social mainstream, making it much more difficult to maintain the range of values, i.e., the inclusiveness of society, without the help of noise.

Conclusion

Noise exists in the understanding of others' values. However, in modern online social networking, the noise has been greatly reduced by technological developments in the pursuit of communication accuracy. Through computer simulations, we demonstrated the downside of too little noise to realize a creative society, i.e., a reinforcement of social fragmentation and monolithicization. Our results suggest that noise plays a key role in maintaining the diversity of social values by preserving local diversity and social inclusiveness. In this sense, noise could be considered as a key factor in realizing a creative society.

It should be noted that this study only considered the effect of typical online social networking on the changes of values. It is unknown to what extent our results can be generalized to other forms of social interaction. Meanwhile, the formation and evolution of values would also be affected by other factors than social interaction. Therefore, the evidence and boundaries of the present findings need to be examined by future studies.

Nevertheless, this work adds to the literature emphasizing the importance of alternative information in social cognition (Salvi et al. 2021). In addition, this study contributes to future social creativity studies using simple and reproducible models of opinion dynamics. We demonstrated that opinion dynamics models can be used to study social creativity resulting from peer interactions. Future works interesting in the interactions between internal and external opinions could develop variants of our model using dynamic categories. We believe that these works could lead to a better understanding of the mechanisms of social creativity.

Author Contributions

GL: Conceptualization, Methodology, Software, Investigation, Visualization, Writing - original draft, review, and editing. XG: Conceptualization, Methodology, Investigation, Writing - review and editing. TH: Conceptualization, Methodology, Resources, Funding acquisition.

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