Social Science Discussion of Spin Glass when Coulomb Blocking Energy Occurs in Filter Bubble Research:Hypothesis in Quantum Field Arguments

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Abstract: This research aims to apply the sophisticated mathematical framework of quantum field theory to the mysteries of the social sciences, in particular, the generation of filter bubbles observed in digital and offline environments and their social consequences. Employing the principles of remote interaction and proximity interaction, we have developed a model based on quantum field theory. The model tracks the evolution of opinions among agents and their collective dynamics, and mathematically represents the resonance of opinions and echo chamber effects within the filter bubble by including non-physical factors such as misinformation and confirmation bias, known as FP ghosting phenomena.The indeterminate ghost phenomenon, a social science concept similar to the uncertainty principle, depicts the variability of social opinion by incorporating information uncertainty and nonlinearities in opinion formation into the model. Furthermore, by introducing the Kubo formula and the Matsubara form of the Green's function, we mathematically express temporal effects and model how past, present, and future opinions interact to reveal the mechanisms of opinion divergence and aggregation. Our model uses multiple parameters, including population density and extremes of opinion generated on a random number basis, to simulate the formation and growth of filter bubbles and their progression to ultraviolet divergence phenomena. In this process, we observe how resonance or disconnection of opinions within a society occurs via a disconnection function (type la, lb, ll, lll). This research aims to take on the challenging task of applying quantum field theory to the social sciences and provide new insights into social phenomena. However, the interpretation of the results requires careful consideration, and empirical verification is a future challenge.Finally, we will share our hypotheses and considerations for the model case of this paper, which is a close examination of regional differences in media coverage and its effectiveness and considerations unique to Japan, a disaster-prone country.

Keywords: Coulomb Blockade, Spin Glass, Quantum Field Theory, Uncertainty Ghost Phenomenon, Confirmation Bias, Remote Interaction, Proximity Interaction, Disaster Reporting, Ultraviolet Divergence, Social Disconnection, Information Uncertainty

1. Introduction

This paper analyzes the creation of filter bubbles and their social consequences in the complex information environment of modern society through the mathematical framework of quantum field theory. It focuses on the phenomena of opinion polarization and information segregation in digital and offline environments, i.e., filter bubbles. Filter bubbles refer to information blockages formed when individuals and groups share similar opinions and beliefs, which can exclude different perspectives and information. Quantum field theory is a theory used in physics to describe the interactions of elementary particles, and this study applies this theory to the context of the social sciences. In particular, we use the principles of remote interaction and proximity interaction to model the evolution of opinions and collective dynamics among individual agents. This approach makes it possible to mathematically represent the resonance of opinions in filter bubbles and echo chamber effects. In addition, this study incorporates non-physical factors such as misinformation and confirmation bias into the model as FP ghosting phenomena. This allows for a deeper understanding of the variability of social opinion and the mechanism of filter bubble formation. By using the uncertainty ghost phenomenon, a social science concept similar to the uncertainty principle, we capture information uncertainty and the non-linearity of opinion formation. We model how past, present, and future opinions interact by introducing the Matsubara form of the Kubo equation and the Green function to mathematically express

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temporal effects. This sheds light on the mechanisms of divergence and aggregation of opinions. It also simulates the formation and growth of filter bubbles and their progression to ultraviolet divergence phenomena by using multiple parameters, including population density and extreme values of opinion generated on a random number basis. In this study, we further extend the Coulomb closure phenomenon and consider filter bubbles in terms of spin glass theory and critical points. Spin glass is a physical system characterized by disorder and frustration (existence of conflicting constraints), which can be applied to the social sciences to model social environments where the flow of opinions and information is heterogeneous and difficult to predict. In a spin glass state, interactions among agents (individuals or groups) are irregular and sometimes conflicting. This is analogous to situations in society where different sources of information and opinions are intricately intertwined, creating unpredictable dynamics. In such an environment, the filter bubble may function as a stable resonant state of opinion, but it can also be rapidly disrupted by minute external stimuli. This study also focuses on the behavior of filter bubbles at critical points. The critical point is the point at which the behavior of the system changes dramatically, and in the social sciences it is the threshold for the propagation of opinions and information. At the critical point, small changes or external influences can have large consequences, which can cause rapid changes in social conditions and public opinion. In the process of filter bubble formation and collapse, Coulomb closure, spin glass theory, and critical point theory can be combined to reveal the nonlinearity and unpredictability of information propagation. Spin glass theory is particularly suited to understanding the dynamic nature of filter bubbles in social environments where opinions and information propagate erratically. Critical points also help to capture rapid changes in opinion and fluctuations in information flow during sensitive periods of social change. This research addresses the challenging issue of applying quantum field theory in the social sciences and provides new insights into social phenomena. It also suggests avenues for empirical verification, including a discussion of regional differences in media coverage and its effectiveness in disaster-prone Japan. Through filter bubble simulations, we will analyze the social science implications of different scenarios of remote and proximity interactions and discuss their advantages and disadvantages in terms of UV divergence and FP ghosting. In particular, the paper discusses the handling of sensitive video and images in the event of a disaster and explores the risks and opportunities of information dissemination. The paper also adopts the Coulomb occlusion phenomenon as a framework for understanding social science, particularly filter bubbles. Coulomb blockage is a quantum mechanical phenomenon in which the interaction of electrons controls the flow of charge in a tiny conductor. Applying this to the social sciences, we propose the concept of social Coulomb blockage, which acts as a barrier to the exchange of ideas and information transfer between agents. In this theoretical framework, a filter bubble is understood as a situation in which certain opinions and information are isolated within a social group, restricting their propagation outside of that group. This is analogous to a situation in which certain information or opinions are confined by a social barrier, just as electrons cannot cross a particular energy barrier in a Coulomb blockage. Furthermore, this study also focuses on the ghosting phenomenon associated with social Coulomb blockage. This concept refers to the interference or influence of apparently non-existent information in social information transfer, analogous to ghost particles in actual quantum mechanics. Ghosting in society can be viewed as a non-physical factor that affects the quality and reliability of information, such as misinformation and confirmation bias. We will also discuss in detail the truncation function as it relates to the generation and propagation of filter bubbles. The truncation function is a mathematical tool that quantitatively describes continuity or discontinuity in the process of information propagation. In this study, different truncation functions, such as Type la (first order phase transition), Type lb (second order phase transition), Type ll (logarithmic phase transition), and Type lll (infinite order phase transition), are used to understand the pattern of information propagation in filter bubbles. This theoretical framework allows us to understand the formation and development of filter bubbles and their social consequences from a new perspective. In particular, through the Coulomb closure and ghosting phenomena, it is possible to gain deeper insight into the mechanisms of information propagation and its barriers, Through these theoretical frameworks, a social scientific understanding of filter bubbles can go beyond the mere isolation of opinions and information to provide deep insights into the dynamics of their formation and collapse, and how they are affected by social context and external environment.

We analyze the Coulomb blockage phenomenon and the critical point on the spin glass from a social science perspective in remote interaction and proximity interaction scenarios. The Coulomb blockage phenomenon is understood as a threshold for information propagation when the critical point in spin glass theory is reached. Using this theoretical framework, it is possible to identify how the formation and dismantling of filter bubbles differs in remote and close interaction scenarios.

In the remote interaction scenario, information and opinions propagate quickly over a wide area. In this case, the critical point of Coulomb closure tends to set a relatively high threshold for information propagation, generating a massive flow of information. From a spin glass theory perspective, the pattern of information propagation in this scenario is highly irregular and unpredictable, and the formation and dismantling of filter bubbles can occur rapidly and unpredictably.

In the proximity interaction scenario, on the other hand, information propagates within a more limited scope, i.e., within close social networks and communities. In this case, the critical point for Coulomb closure is set lower, and the flow of information is restricted and may exhibit more predictable patterns. From the spin glass perspective, information propagation is relatively stable, and filter bubbles tend to form more slowly and persist over longer periods of time.

Using the disconnection functions (Type la, lb, ll, lll) of the Coulomb blocking energy on the spin glass, we explore the validity from a social science perspective of filter bubbles in remote and near interaction scenarios. Coulomb blocking energy is understood as the energy that must exceed a specific threshold in the exchange of opinions and information between agents, and its disconnection function quantitatively describes the continuity or discontinuity of information propagation.

In remote interaction scenarios, Type la (first-order phase transition) and Type lb (second-order phase transition) disconnection functions are useful because information propagates rapidly over a wide area. These functions represent abrupt or gradual transitions in information propagation. In remote interactions, information and opinions can propagate rapidly over a wide area, and the formation and collapse of filter bubbles can occur suddenly. In this scenario, the rapid formation and disintegration of the filter bubble is observed and can have a significant impact on social dynamics.

In the close interaction scenario, on the other hand, information propagates more slowly within a limited range, so Type ll (logarithmic phase transition) and Type lll (infinite order phase transition) disconnection functions are applied. These functions exhibit more gradual and continuous changes in the process of information propagation. Under proximity interactions, filter bubbles tend to form more stably and remain for longer periods of time. In this scenario, changes in the filter bubble are gradual and predictable because the exchange of ideas and information takes place within a limited community.

Using the disconnection function of the Coulomb blocking energy on the spin glass, it is possible to better understand the social science properties of the filter bubble in the remote and near interaction scenarios. In particular, it can shed light on the continuities and discontinuities in information propagation, the mechanisms of filter bubble formation and collapse, and how they differ depending on the social context and external environment. This extends the theoretical foundations of information propagation in the social sciences and provides new insights.

Using the disconnection function of Coulomb blocking energy on spin glass (Type la, lb, ll, lll), the social science aspects of filter bubbles in remote interaction and proximity interaction scenarios conditioned on mass media and online media senders and recipients in metropolitan and village societies We clarify the This approach allows us to understand how the mechanisms of information dissemination and the formation of filter bubbles differ depending on the characteristics of different social settings and information sources.

In remote interaction scenarios, mass media have far-reaching influence and information tends to spread quickly, especially in large cities. In this case, Type la (first-order phase transition) and Type lb (second-order phase transition) disconnection functions indicate rapid changes in information propagation, and the formation of filter bubbles is likely to occur suddenly. On the other hand, since individual agents are more active in selecting and sharing information in online media, filter bubbles may be more individualized and information diversity may increase.

In the proximity interaction scenario, information propagation is more restricted in close-knit communities such as village communities, where Type ll (logarithmic phase transition) and Type lll (infinite order phase transition) disconnection functions are applied. Here, filter bubbles tend to form more slowly and information flows tend to be more predictable and stable. Mass media and online media influences can cause different reactions in these communities, and the process of information dissemination has more localized characteristics.

Considering ultraviolet divergence and indefinite ghosting phenomena on spin glass and using Coulomb blocking energy disconnection functions (Types la, lb, ll, lll) in remote and proximity interaction scenarios conditioned on mass and net media senders and recipients in large cities and village communities This section reveals the social science aspects of filter bubbles.

Ultraviolet divergence can be understood as a phenomenon in which information spreads very quickly, causing a rapid resonance of opinion. This phenomenon can be particularly pronounced in metropolitan scenarios where the mass media are the originators. In this situation, the Type la (first-order phase transition) disconnection function is valid, and rapid diffusion of information and rapid formation of filter bubbles can occur.

On the other hand, the phenomenon of indefinite ghosting refers to the process of propagation of information uncertainty and misunderstanding, and is particularly relevant to information dissemination through online media. Especially in village societies, this uncertainty can be captured by Type ll (logarithmic phase transition) and Type lll (infinite order phase transition) disconnection functions, which show a more gradual and continuous change in the process of information propagation.

In the remote interaction scenario, information from the mass media propagates quickly over a wide area, promoting the formation of filter bubbles in large cities. In contrast, in the proximity interaction scenario, information from the online media tends to propagate over a more localized area and filter bubbles tend to persist longer in village communities.

This theoretical framework allows us to understand the formation of filter bubbles and their social science properties in different information source and recipient settings. The consideration of ultraviolet divergence and indeterminate ghosting provides a new perspective on the process of information propagation and the dynamics of filter bubbles, contributing to the further development of information propagation theory in the social sciences.

If the opposite phenomenon to the above reasoning is observed, i.e., information propagation is slow and uncertain in large cities, while information spreads quickly in village communities, the theoretical interpretation and response will be discussed.

Theoretical Interpretation

1. **Looseness of information propagation in large cities**:

    In large cities, diverse information sources and a high degree of connectivity may promote more careful consumption of information rather than its rapid dissemination, as information is selected and verified through a variety of sources.

    High information literacy and critical thinking skills in large cities may encourage verification of information from multiple perspectives rather than relying on a single source of information.

2. **Rapid dissemination of information in village society**:

    In village societies, close community structures facilitate rapid dissemination of information. Information sharing based on trust may cause rapid opinion formation.

    In a village society, new sources of information (especially online media) may act as a freshness and interest factor, facilitating rapid dissemination of information.

Responses

1. **Multi-faceted information dissemination strategies in large cities**:

    It is important for information providers to offer information that includes diverse perspectives to recipients in large cities.

    In large cities, strategies that emphasize reliability and accuracy of information will be effective.

2. **Strengthening the accuracy and verification of information in village communities**:

    In village communities, it is necessary to emphasize accuracy and verification of information to prevent the spread of misinformation.

    Information from reliable sources and the development of information dissemination methods appropriate for local communities are required.

This situation provides an opportunity for theoretical models of information dissemination to gain a deeper understanding of the impact of different social settings and cultural backgrounds on information acceptance and dissemination. It also allows for a reexamination of theoretical approaches to the dynamics of information dissemination.

2. Discussion:Discussion of remote vs. proximity interactions

The discussion of remote and close interactions is illustrated as phenomena that can occur in society. Applying these concepts to social phenomena will help us understand the impact of relativity and quantum theory.

1. Remote Interaction

Description

Remote interaction refers to the phenomenon of objects and information interacting at spatially distant locations. This can apply to many phenomena such as communication, information transfer, and social influence. Below are some examples of remote interactions that can occur in society.

Examples in Society

(1) **Distance Education**: In distance education programs, the educational process takes place even though the teacher and student are physically separated. Information is transmitted remotely between educator and learner, and learning takes place.

(2) **Social Media Impact**: In social media platforms, information, ideas, and trends are shared and spread remotely among users. A phenomenon occurs where the actions and opinions of people in remote locations influence others.

(3) **International Politics and Diplomacy**: In international politics, different countries and governments interact remotely to coordinate international relations and foreign policy. International decisions and cooperation take place at a distance.

2. Proximity Interaction

Description

Proximity interaction refers to the phenomenon of objects and information interacting in close proximity. It is associated with physical contact and local influence. Below are examples of proximity interactions that can occur in society.

Examples in Society

(1) **Face to Face Meetings**: In meetings and gatherings, people gather in the same place to discuss and exchange ideas face to face. Physical proximity is important, and direct communication takes place.

(2) **Workplace Interaction**: In the workplace, people working in the same office or factory are in close proximity. This allows teams to cooperate and collaborate, and work proceeds efficiently.

(3) **Local Communities**: In local communities, neighbors live in close proximity and work together on local issues and events. Proximity creates a sense of community togetherness.

Impact of the Uncertainty Principle

The uncertainty principle affects physical events, especially at the microscopic level. When applied to social phenomena, the uncertainty principle can be interpreted as follows:

The uncertainty principle can affect the accuracy of information and the difficulty of prediction in information transfer and decision making in society. For example, individual actions and decisions are difficult to predict and may have different outcomes depending on the situation. Uncertainty also exists in the communication and interpretation of information, which can lead to misunderstandings and the spread of misinformation.

In short, the concepts of relativity and quantum theory, while not directly applicable to the social sciences and real social phenomena, can provide different perspectives and approaches when considering interactions and the existence of uncertainty in society in terms of remote and near interactions. In this paper, we will keep in mind the perspective of approaching this ambiguous definition from the discussion of quantum theory of fields.

Coulomb Closure in Nanoscale Electronic Devices

Coulomb closure is a phenomenon relevant to electrical engineering and condensed matter physics, especially in nanoscale electronic devices.

Basics of Coulomb Occlusion

Coulomb blockage is a phenomenon in very small nanoscale electronic devices in which electrons are prevented from entering the device by the tunneling effect. This is due to Coulomb interactions that prevent electrons from entering the device unless the energy of the charge exceeds a certain threshold value.

Relation between Quantum Field Theory and Coulomb Blockage

When considering Coulomb closure in the context of quantum field theory, electrons and other charged particles are understood as excitations of quantum fields. From this perspective, Coulomb closure can be thought of as follows:

(1) **Quantum field excitations**: Electrons are represented as excitations of the electron field, and the interactions between these particles are described by the field interactions.

(2) **Coulomb interaction**: The Coulomb interaction between particles in an electron field restricts an electron from entering a region where other electrons exist. This may be described as an increase in interaction energy in field theory.

(3) **Energy Barrier**: When a Coulomb blockage occurs within a nanoscale device, an electron must exceed a specific energy barrier to enter the device. This can be thought of as a potential energy increase in field theory.

Metaphorical Interpretation of Coulomb Blockage and Filter Bubble

To apply Coulomb blockage to the context of the filter bubble, the following metaphorical interpretations can be made:

(1) **Barrier to information transfer**: The blockage of electron flow in a Coulomb blockage can be interpreted as a barrier that prevents the transfer of different opinions and information in a filter bubble. This barrier can be reinforced by an individual's existing beliefs and preferences.

(2) **Echo Chamber Effect**: Within the filter bubble, the same opinions and ideas are emphasized, and different opinions are blocked. This is analogous to the phenomenon of one electron blocking the path of another electron in a Coulomb blockage.

(3) **Opinion bias and information bias**: The restriction of electron flow due to Coulomb blockage corresponds metaphorically to information bias and opinion bias in the filter bubble. When information sources are limited, certain viewpoints and opinions may be reinforced, and diversity may be lost.

Application of Coulomb Blockage

This theoretical approach is hypothetically introduced to understand information flow and opinion formation in filter bubbles. For example, applying the concept of Coulomb occlusion in analyzing how social media platforms and news feed algorithms promote or suppress certain information may help us better understand the mechanisms of barriers to information transfer and echo chamber effects.

Filter Bubbles and Information Barriers

In a filter bubble, people are surrounded by information with similar opinions and ideas, reducing their exposure to different opinions and perspectives. From the perspective of Coulomb closure, this can be thought of as a condition in which new and different information cannot reach an individual unless the information flow exceeds a certain "threshold."

Information Friction and Resistance: The flow of information within the filter bubble can be viewed as friction or resistance in a Coulomb blockage. Information diversity is restricted as certain opinions and ideas are emphasized, and different opinions are suppressed.

Confirmation Bias as Induced Magnetic Forces: Induced magnetic forces within the Coulomb blockage can be interpreted as a confirmation bias that reinforces an individual's existing beliefs and biases in the filter bubble. Due to this bias, people tend to selectively accept information that is consistent with their views and ignore information that contradicts them.

Identifying Critical Points

Critical points in the filter bubble refer to moments when important changes occur in the flow of information or in the formation of opinions. For example, this is the moment when new information breaks through the filter bubble and influences an individual's opinions and beliefs. In the context of Coulomb closure, this can be viewed as the moment when electrons flow beyond the energy barrier.

Thus, applying the concept of Coulomb blockage to filter bubbles can provide a new perspective on barriers to information flow and opinion formation. However, this is a metaphorical application and does not represent a direct scientific correlation.

Addressing Social Controversies through Quantum Disconnection

When phenomena such as Coulomb blockage in a filter bubble occur, the flow of information is restricted to certain groups or opinions, and social controversy is likely to occur. In such situations, one way to alter the flow of information is through disconnection. Considering this in the context of quantum disconnection, the following considerations can be made.

Types of Social Controversies

1. **Echo Chamber Effect (Type Ia)**: The gathering of people with the same opinions and ideas reinforces certain viewpoints and suppresses different viewpoints.
2. **Reinforced Prejudice (Type Ib)**: An individual's existing beliefs and prejudices are reinforced, and receptivity to new information and different opinions is reduced.
3. **Increased Extremism (Type II)**: Information bias may promote extreme opinions and extreme behavior.
4. **Increased Conflict (Type III)**: Conflicts between different opinions may intensify, and social divisions may deepen.

Considerations in the Context of Quantum Disconnection

Quantum disconnection, in quantum information theory, refers to the process of severing interactions and correlations between quantum states. When considering quantum disconnection in the context of filter bubbles, the following approaches are possible:

1. **Redistribution of Information**: Quantum disconnection restructures the flow of information so that different opinions and information reach new groups. This may reduce the echo chamber effect and spread diverse information.
2. **Diversification of Opinions**: Quantum disconnection provides access to different opinions and sources of information and promotes diversification of individual thoughts and beliefs.
3. **Reduction of Social Conflict**: By facilitating the exchange of information between different opinions, it prevents the escalation of conflict and allows for more inclusive discussions.
4. **Regulating the Flow of Information**: It can be used as a means to deliberately regulate the flow of information and prevent the reinforcement of extremism and prejudice.

Examples of Actual Hypothesis Testing Implementation Methods

The best way to implement quantum disconnection is through the use of digital environments. Algorithmic adjustments in social media platforms and news aggregators are necessary. This includes designing algorithms that actively provide different perspectives and sources of information, as well as technical interventions to diversify users' information exposure.

Thus, applying the concept of quantum disconnection to filter bubbles can provide new solutions to information flows and social controversies. However, this is a metaphorical application and does not represent a direct scientific correspondence.

3. Discussion:Frictional and Resistive Forces in Filter Bubbles

The hypothesis that "energy" such as frictional and resistive forces are generated during phenomena such as Coulomb blockage within a filter bubble, which contribute to the formation of critical points, provides insight into the flow of information and its barriers in the digital environment. The "frictional and resistive forces" here metaphorically represent barriers and constraints in the transmission of information and the formation of opinions.

Example: Frictional and Resistive Forces in a Filter Bubble

1. Example of Frictional Forces

Echo Chamber: An environment in which people with the same opinions and preferences gather, making it difficult for different outside opinions to penetrate. Here, "frictional forces" act as forces that hinder the introduction of new information and different opinions.

Information Overload: A situation in which a large amount of information exists, and individuals are likely to select only information that is consistent with their existing beliefs and opinions. Mental friction in adopting new information increases.

2. Cases of Resistance

Confirmation Bias: A tendency for individuals to prefer information that is consistent with their beliefs and existing knowledge and to resist information that contradicts them. This resistance inhibits the adoption of new perspectives.

Algorithmic Information Filtering: Social media and news aggregators filter content based on users' past behavior, increasing exposure to certain types of information while creating resistance to others.

Critical Point Generation

As these frictional and resistive forces build up, a critical point can be reached, which is the point at which it becomes difficult to change opinions and beliefs within the filter bubble. A critical point is the point at which

Examples of Frictional and Resistive Forces

1. Examples of Frictional Forces

Information Overload: In the digital environment, users are constantly exposed to vast amounts of information. This information overload can be a frictional force against the acceptance of new information and different perspectives.

Echo Chambers: Online communities of people with similar opinions and beliefs can increase frictional forces against different opinions and decrease information diversity.

2. Cases of Resistance

Confirmation Bias: Individuals tend to prefer information that is consistent with their own beliefs and past experiences. This creates resistance to new information and differing opinions, limiting the diversity of opinions within the filter bubble.

Algorithmic Filtering: Social media and news app algorithms filter content based on users' past behavior. This can increase resistance to different viewpoints and information.

Critical Point Occurrence

The accumulation of these frictional forces and resistances can lead to a critical point, or critical turning point, in a social controversy. This point is the moment when the acceptance of information or the flow of opinion within a community changes dramatically. For example, a critical point is when a particular incident or new information breaks through the filter bubble and challenges existing opinions and beliefs.

Critical Point Suppression

In order to suppress phenomena such as Coulomb blockage within the filter bubble and the associated frictional and resistive forces, it is important to diversify the flow of information in the digital environment and promote open discussion. This includes coordinating algorithms, enhancing information literacy education, and promoting dialogue among communities with different perspectives.

Coulomb Blocking Energy in Filter Bubbles

The concept of Coulomb blockage in the filter bubble refers to the phenomenon of information and opinions being trapped within a particular group or network in a digital environment. The "Coulomb blocking energy" here can be taken as a metaphor for the "energy" required for different opinions and information to break through the filter bubble. This situation implies that frictional and resistive forces are at work in the flow of information and opinions, and the accumulation of these forces is considered to create a critical point, or moment of significant change.

Coulomb Confinement Concept

The flow of information in a digital environment is considered analogous to the phenomenon within an electronic device where the flow of electrons is controlled by Coulomb forces. It refers to a situation in which information is trapped within a particular group or network, restricting its outflow to the outside.

Frictional and Resistive Forces

These concepts refer to barriers in the transmission of information and opinions. Frictional forces represent psychological, cultural, or technological factors that make it difficult to accept new information, while resistive forces indicate people's adherence to existing beliefs and opinions.

Critical Point Formation and Countermeasures

Critical points are moments of change that occur when these barriers cross certain thresholds. For example, it is the moment when a new social or political event or a significant scientific discovery breaks through the filter bubble and challenges existing opinions and beliefs. Measures to mitigate these moments include diversifying information sources, increasing digital literacy, and promoting dialogue and debate. This improves the flow of information and opinions.

Examples of Coulomb Blocking Energy in Social Controversy

Coulomb Blocking Energy Social Controversy Examples

1. Echo Chamber Effect

Echo chambers are a phenomenon in which users are exposed only to information with opinions and beliefs similar to their own. This phenomenon reduces information diversity by inhibiting the introduction of new information and different points of view and reinforcing existing opinions.

2. Confirmation Bias

Confirmation bias is the tendency for users to prefer only information that is consistent with their existing beliefs and opinions and to ignore information that contradicts them. This acts as resistance to differing opinions and information, further limiting the diversity of viewpoints within the filter bubble.

Friction and Resistance Factors when They Occur

1. Friction Factor

Information Overload: The oversupply of information on the Internet can cause people to miss important information. This can act as a friction against the acceptance of new information and reduce the diversity of information in the filter bubble.

Algorithmic Information Filtering: Social media algorithms filter information based on users' past behavior, which can limit exposure to differing opinions and create friction.

2. Resistance Factor

Group Polarization: Online group discussions often lean toward extreme views, which can increase resistance to differing opinions.

Platform Governance Policies: Some digital platforms have strict regulations on certain types of content, which can inhibit the diversity and distribution of information.

Formation of Critical Points and Countermeasures

When these frictional and resistive forces accumulate within the filter bubble and exceed a certain threshold, a major shift in opinion, an intensification of social controversy, or a critical point may be reached. The following measures can be taken to mitigate these situations:

Diversification of Information Sources: The design of algorithms should be reviewed to allow users to access a variety of information sources and be exposed to different points of view.

Improvement of Digital Literacy: It is important that users develop the skills to critically evaluate the quality of information and to obtain information from different sources.

Promoting Dialogue and Discussion: Online platforms can reduce the effects of echo chambers by providing an environment that encourages dialogue and discussion between different opinions.

Interpreting Spin Glass Phenomenon and Coulomb Blockade in the Context of Filter Bubbles

When interpreting the spin glass phenomenon and Coulomb blockade in the context of filter bubbles, it refers to the phenomenon where the exchange of information and opinions in a digital environment occurs according to specific patterns or restrictions. The spin glass phenomenon refers to systems with complex local minima due to random perturbations and irregular interactions, and when applied in the context of social sciences, it suggests situations where individual opinions or beliefs are linked in unpredictable patterns and become fixed. Coulomb blockade refers to a state where specific information or opinions are less likely to be transmitted to other groups.

Social Controversy Scenarios in Spin Glass Phenomenon and Coulomb Blockade

1. **Opinion Fixation and Division:**

   The spin glass phenomenon leads to the fixation of individual opinions within complex echo chambers due to intricate interactions. This makes it more likely for divisions in opinions to occur between social groups.

2. **Isolation of Information:**

   The influence of Coulomb blockade results in certain groups or communities being less exposed to external information or different opinions. This creates a situation in the digital environment where specific opinions or information are confined to particular networks.

Friction and Resistance Factors When Occurring

1. **Friction Factors:**

   Information Overload: Users are exposed to a vast amount of information on the internet. This leads to friction in selecting and accepting new information, reinforcing a tendency to rely on limited information sources.

   Algorithmic Content Filtering: Social media platforms and online services often employ algorithms that filter and personalize content. This can contribute to the formation of filter bubbles by showing users content aligned with their existing beliefs and preferences.

When considering social controversies in cases where filter bubbles within Coulomb blockade occur during the process of the spin glass phenomenon, it is essential to identify the friction and resistance factors that affect the flow of information and the formation of opinions in the digital environment. The spin glass phenomenon refers to the formation of heterogeneous structures through random interactions, and Coulomb blockade refers to situations where information or opinions are confined within these structures.

Social Controversy Scenarios in the Spin Glass Phenomenon

1. **Fragmentation of Opinions:** The spin glass phenomenon suggests that opinions are fixed in unpredictable patterns within social networks. This can lead to strong resonance of opinions within small groups and potentially result in significant social controversies.
2. **Bias in Information:** Coulomb blockade results in specific information or opinions being confined to particular groups, making it less accessible to others. This leads to the circulation of biased information, potentially causing social misunderstandings and conflicts.

When considering the spin glass phenomenon and Coulomb blockade in the context of a digital environment, especially within the framework of filter bubbles, it refers to the phenomenon where the flow of information and the formation of opinions occur following specific patterns or constraints. The spin glass phenomenon refers to systems with complex local minima due to random perturbations and irregular interactions, and when applied in the context of social sciences, it suggests situations where individual opinions or beliefs are linked in unpredictable patterns and become fixed. Coulomb blockade indicates a state in which specific information or opinions are less likely to be transmitted to other groups.

Here, if we hypothetically consider causal Green functions, advanced Green functions, and retarded Green functions as movements within the digital environment, these would be postulated to understand the dynamics of information transmission.

Causal Green Functions

Causal Green functions represent how certain information or opinions propagate within a digital environment. This function models how information from a particular source influences other users with a temporal delay. Within a filter bubble, causal Green functions can illustrate how information propagates within a specific community and how external propagation is constrained.

Advanced Green Functions

Advanced Green functions indicate how information or events affect the future. In the digital environment, they are used to analyze how specific events or information influence future user behavior and opinion formation. Within a filter bubble, this function can show how certain information influences the opinions and actions of a community in the future.

Retarded Green Functions

Retarded Green functions illustrate how past events or information impact the current state. In the digital environment, they are used to understand how past information or opinions influence current user behavior and opinions. Within a filter bubble, understanding how past information influences the formation of opinions within a community can be facilitated using this function.

Utilizing these Green functions allows for a deeper understanding of the complex dynamics of information transmission in the context of filter bubbles and the spin glass phenomenon.

3.1 Case of Hypothesis of FP Ghosts

In cases where filter bubbles occur within Coulomb blockade during the process of the spin glass phenomenon, hypothesizing the occurrence of FP ghosts and ultraviolet divergence as movements within the digital environment can be one way to analyze the highly complex interactions in the flow of information and the formation of opinions. FP ghosts (Faddeev-Popov ghosts) and ultraviolet divergence are originally concepts in quantum field theory, but here, let's metaphorically apply them in the context of information transmission and opinion formation.

Hypothesis of FP Ghosts, Ultraviolet Divergence

FP ghosts refer to specific correction elements in quantum field theory, but in a digital environment, they can refer to the "hidden" influences or biases that occur during information transmission. In the context of the spin glass phenomenon, this may manifest as invisible constraints on diversity of opinions and the flow of information. For example, algorithms for information filtering or the design of social media platforms can fall under this category, as they may have unforeseen effects on user opinions and behaviors.

Hypothesis of Ultraviolet Divergence

Ultraviolet divergence refers to a phenomenon in physics where energy diverges to infinity, but in a digital environment, it can be thought of as a metaphor for "escalation" or "extremism" in the flow of information and opinion formation. In other words, it indicates situations where specific information or opinions are excessively emphasized, leading to the amplification of extreme opinions or misinformation within a filter bubble. This may occur as biased information circulates within an echo chamber, reinforcing users' extreme opinions and biases.

In this way, the hypotheses of FP ghosts and ultraviolet divergence in the context of the spin glass phenomenon and Coulomb blockade suggest that the flow of information and the formation of opinions in the digital environment are shaped by highly complex and unpredictable interactions.

Considering the relationship between filter bubbles within Coulomb blockade during the process of the spin glass phenomenon and FP ghosts and ultraviolet divergence can be helpful in understanding the complexity of information propagation and the hidden influences on opinion formation in the digital environment.

4. Discussion:Coulomb Blockage Applying Filter Bubble

When Coulomb blockage occurs within a filter bubble, it is assumed to be the result of friction, resistance, or physical and non-physical interruptions in the flow of information. Let's consider the previous discussions in a general formula.

The concept of Coulomb blockage is mainly used to describe the behavior of electrons in solid-state physics, especially in nanoscale electronic devices. However, in the context of social sciences, this concept can be used as a metaphor for situations where obstacles arise in the flow of information and the exchange of opinions, such as the formation of filter bubbles and echo chambers. This metaphor will be used to explain how to model "Coulomb blockage" in the flow of information.

4.1 Mathematical Expression of Coulomb Blockage

To mathematically model Coulomb blockage, we need a model that takes into account the interactions between agents. This can be done in the following steps:

(1) **Setting Energy Barriers between Agents:** Each agent has a certain energy barrier (obstacle) for exchanging information with other agents. This can represent differences in opinions or communication difficulties.

(2) **Modeling the Probability of Information Exchange:** The probability of information exchange between agents depends on these energy barriers. Higher barriers reduce the probability of information exchange.

(1) **Initialization of Agent Opinions and Energy Barriers:**

Set the opinions of agents O_i.

Set the energy barriers between agents B_{ij}. This represents the degree of difference in opinions and communication barriers between agents.

(2) **Simulation of Information Exchange:**

At each time step, determine whether information is exchanged between agents.

The probability of information exchange is influenced by the energy barrier B_{ij}. For example, the exchange probability can be expressed as $e^{-B_{ij}}$.

(3) **Calculation of Entanglement Entropy:**

Calculate the entanglement entropy S_{ent} to reflect the complexity of information exchange.

(4) **Progression of the Scenario:**

Update opinions, recalculate energy barriers, and evaluate new information exchange probabilities.

4.2 Theoretical Clarification

In this model, the physical concept of Coulomb blockage is applied to information exchange. In physics, Coulomb blockage refers to the phenomenon where electrons are hindered from moving within a nanoscale device due to energy barriers. In the context of social sciences, these barriers represent blockages and closures in the flow of information and communication due to differences in opinions, misunderstandings, or discussions in digital environments.

To propose a general formula for modeling Coulomb blockage in this context, the focus should be on the interactions between agents.

4.3 General Formula for Coulomb Blockage

To model the probability P_{ij} of information exchange between agents, consider the following equation:

$$P_{ij} = e^{-\alpha B_{ij}}$$

Here,

P_{ij} represents the probability of information exchange from agent i to agent j.

B_{ij} represents the energy barrier between agents, reflecting the degree of difference in opinions or communication barriers.

α is a coefficient that adjusts the influence of the barrier, controlling the system's sensitivity.

4.4 Supplementary Explanation

This equation is inspired by the physics of Coulomb blockage. In physics, Coulomb blockage is related to the behavior of electrons within nanoscale devices, where electrons cannot move unless they overcome a specific energy barrier. In social sciences, this energy barrier is represented as differences in opinions, misunderstandings, or communication barriers, making information exchange difficult.

4.5 Application of the Model

This model is particularly useful for studying phenomena such as opinion polarization and the formation of filter bubbles. When the energy barrier B_{ij} between agents is high, the probability of information exchange P_{ij} is low, increasing the likelihood of information isolation between agents. Using this model, one can explore the dynamics of interactions between individuals or groups with different opinions and beliefs, and devise strategies to overcome communication barriers.

The results represent simulation results that model interactions between agents and Coulomb blockages (states of opinion rigidity or resistance). In this discussion, we focus on the generation of filter bubbles and opinion rigidity.

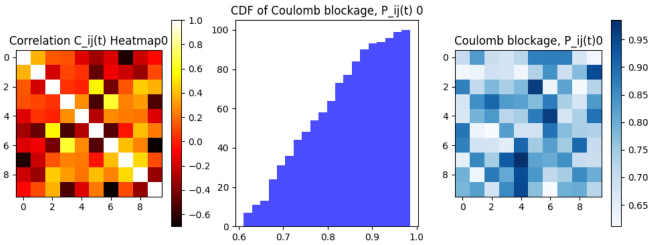

Fig. 1: Correlation, Coulomb blockage Maps, t=0

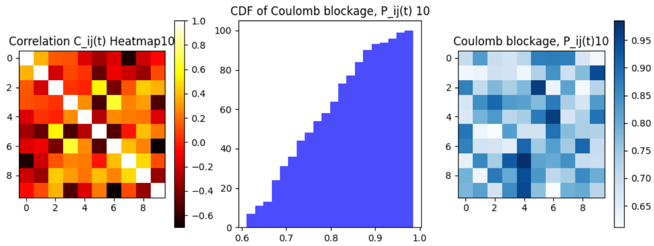

Fig. 2: Correlation, Coulomb blockage Maps, t=10

1. a heat map of correlation coefficients

2. cumulative distribution function (CDF) of Coulomb blockage

3. heat map of Coulomb blockage

We begin with the heatmap of the correlation coefficient. This represents the correlation of opinions among agents. The brighter the heatmap (yellow to near white), the stronger the correlation, and the darker (red to near black), the weaker the correlation. Filter bubbles occur when opinions are strongly correlated with each other, which refers to a state where diversity of opinion is lost as agents continue to share the same

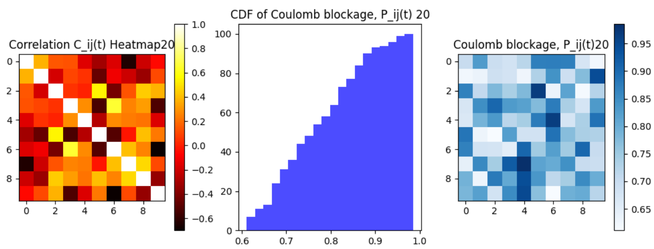

Fig. 3: Correlation, Coulomb blockage Maps, t=20

information and opinions. As the simulation progresses, it is important to identify whether correlations are getting stronger among some agents or whether the pattern of correlations is changing.

The CDF of Coulomb closure then shows the degree of rigidity of opinion among agents. If the graph is rising diagonally toward the upper right, it means that more agents are showing higher blockage (i.e., resistance to opinion change); by looking at whether the CDF is changing step by step, we can determine whether opinion rigidity is increasing or decreasing over time can be used to determine whether opinion rigidity is increasing or decreasing over time.

Finally, the heatmap of Coulomb closure details the distribution of opinion rigidity across agents. Lighter colors (lighter blue) indicate lower obstruction, while darker colors (darker blue) indicate higher obstruction. Through this heat map, we can observe how a particular agent pair changes over time.

Let us now discuss each graph in detail. First, we will review the images provided and take a closer look at their contents.

After looking at the three graphs, we can make the following observations.

4.6 Heatmap of correlation coefficients: rigidity of opinion among agents with increasing correlation coefficients

In each graph, the heatmap showing correlation coefficients among agents changes in color intensity, which indicates that the correlation of opinions among agents changes over time. At the first time step, the correlation coefficients range from 0.4 to 0.9, but as time goes on, we see that the correlation coefficients are increasing among certain agents. This may indicate that some agents are becoming more in agreement with others and that a filter bubble is forming.

4.7 CDF of Coulomb Blockage

The CDF graph shows an overall shift to the right as we move from step 0 to 20. This indicates an overall increase in Coulomb blockage over time, implying a progressive rigidity of opinion among agents. The CDF at step 10 is slightly flatter than at step 0, possibly indicating an intermediate state.

4.8 Heat Map of Coulomb Blockage: Rigidity of Opinions

This heat map provides a visual representation of the degree of Coulomb blockage across agents. As one progresses from step 0 to step 20, one can see that the overall color of the heatmap becomes lighter. This indicates an increase in resistance to change in opinion among agents, meaning that opinions are becoming more rigid.

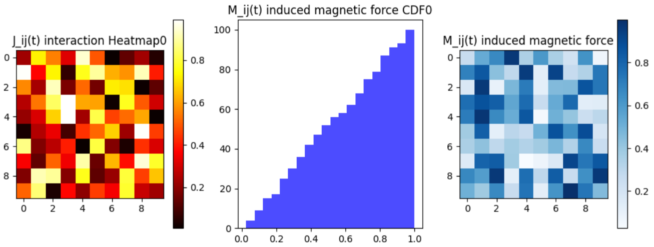

Fig. 4: Interaction, Induced magnetic force Maps, t=0

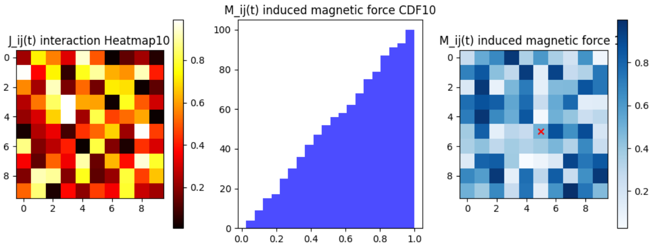

Fig. 5: Interaction, Induced magnetic force Maps, t=10

4.9 Strengthening of Coulomb Blockage

The overall trend shows that the correlation of opinions among agents increases over time, indicating a strengthening of the Coulomb blockage. This suggests that filter bubbles and opinion rigidity may be more likely to occur within social networks. When opinions become rigid, receptivity to new information and different perspectives may decrease, creating a situation where information circulates only within filter bubbles.

These simulation results are very important for understanding the dynamics of opinion formation and information diffusion in digital platforms and social networks. Filter bubbles and opinion rigidity can affect the quality of public debate and promote extreme polarization of opinion. Monitoring and properly managing these phenomena is critical to maintaining a healthy public space.

These resultant graphs show the intensity of interactions and induced magnetic forces between agents and observe their variation over time in terms of filter bubble generation and Coulomb occlusion states (opinion rigidity) on digital

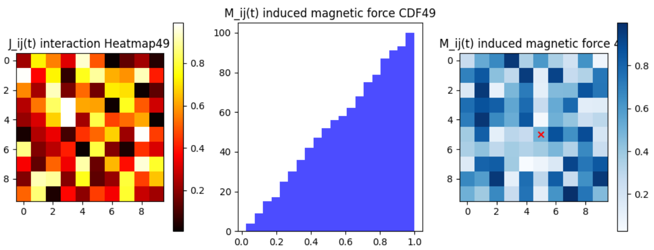

Fig. 6: Interaction, Induced magnetic force Maps, t=49

discourse.

4.10 Interaction heat map

This heat map shows the intensity of interaction between agents. Lighter colors indicate stronger interactions, while darker colors indicate weaker interactions. This interaction mimics the frequency and intensity of the exchange of ideas and is an important factor affecting the formation of filter bubbles.

4.11 Cumulative Distribution Function (CDF) of Induced Magnetic Force

This CDF shows the distribution of induced magnetic forces. This graph shows the degree of induced magnetic force generated between agents and how much each individual agent is influenced (or is influenced) by other agents in the filter bubble. The more it slopes to the right, the more agents exhibit higher induced magnetic forces.

4.12 Heatmap of induced magnetism

This heat map shows the degree of induced magnetic force between agents. The brighter the color, the higher the magnetic induction, and the darker the color, the lower the magnetic induction. Agents with high induced magnetism indicate that they may have a strong influence on other agents.

Analyzing these graphs over time allows us to understand how the process of filter bubble formation and opinion rigidity evolves. Of particular interest is how the interactions between agents change over time, how the induced magnetic forces are distributed, and how the critical points (the points marked in red) are affected.

4.13 Heatmap of interactions

Comparing the heatmaps of interactions across time steps 0, 10, and 49, we see that there are consistently strong interactions (light colors) among some agents and weak interactions (dark colors) among others. This indicates that some diversity of opinion is preserved, but over time we may see a trend toward stronger interactions between certain agents. This may suggest an early stage of filter bubble formation.

4.14 CDF of induced magnetic forces

The CDF of induced magnetic force increases monotonically toward the upper right at each time step. This indicates that all agents have some degree of induced magnetic force, meaning that the agents are interacting with each other. It is important to check if the shape of the CDF changes over time or if it maintains a constant distribution.

4.15 Heat Map of Induced Magnetic Forces

The heat map of induced magnetic force shows the relative strength of induced magnetic force between agents. It is consistently observed that the induced magnetic force is stronger (lighter color) between certain agents, but there is a red "X" mark at time steps 10 and 49. This probably indicates that a significant event occurred at a particular point in the simulation, which is an important clue in considering how this affected the interaction between agents and the induced magnetic force.

The main insight that can be gleaned from these graphs is that the interactions between agents and the induced magnetic forces have changed over time. With respect to the intensity of interactions between agents, no specific pattern of change is observed from time step 0 to 49, but for induced magnetic force, a significant change (marked by a critical point) is observed at a specific time step. In terms of filter bubble generation and opinion rigidity, additional analysis is needed to understand how these critical points contribute to the formation and dismantling of filter bubbles and the acceleration or deceleration of opinion rigidity.

The formation of filter bubbles in digital discourse is caused by biased sharing and acceptance of information among agents. Agents with high induced magnetism may enhance the resonance of opinions within the filter bubble, and critical points may play an important role in this process.

The heatmap of induced magnetic force across agents Light colors indicate strong induced magnetic forces. It can be seen that the distribution at this point is somewhat uneven, with marked differences between agents. In particular, the agent with the red "X" mark in the center shows a lower induced magnetic force than the other agents, which may indicate a critical point. This can be interpreted as a reflection that the agent is facing some critical event or situation change, resulting in a weakened interaction with other agents and a lower induced magnetic force.

The presence of this critical point may be an important turning point in the formation of filter bubbles and rigidity of opinion. For example, if this agent is a critical source of information and its information and opinions no longer influence other agents, the diversity of opinions in the filter bubble may decrease. Conversely, if this agent has a different point of view, its reduced influence may strengthen the filter bubble.

Overall, the distribution of the intensity of interactions and induced magnetic forces among agents at time step 49 indicates that the process of filter bubble formation and opinion rigidity is dynamic and that the states and interactions of individual agents play an important role. To understand the development of filter bubbles and their evolution, it is important to track and analyze the dynamics of interactions between agents and changes in induced magnetic forces over time. Comparing the heatmap of interactions between agents with the heatmap of induced magnetic forces, we see a tendency for the intensity of interactions to be higher when induced magnetic forces are higher between particular agents. This suggests that when opinions and information resonate strongly within a particular group and there is little interaction with outside agents, filter bubbles are more likely to occur. The presence of agents whose induced magnetic force is generally high but declines at critical points may also suggest that openness to outside information and different perspectives may suppress the effects of filter bubbles.

A decrease in induced magnetism at the critical point may indicate resistance to or a change in rigidity of opinion. Such agents may deviate from resonance within the filter bubble and access more diverse sources of information and opinions. This may lead to a weakening of the filter bubble effect and preserve the diversity of opinion in society as a whole.

Ultimately, such simulations can mimic real social interactions and the mechanisms of information diffusion on digital platforms, helping to understand phenomena such as filter bubbles and opinion rigidity. We hope that this information can be used to develop strategies to improve the health of digital discourse.

5. Scenario: Modeling the Suppression of Fake News and Fragmentation of Accurate News

In this scenario, we will construct a model considering the suppression of fake news and the fragmentation of accurate news, leading to the phenomenon of spin glass. We will use Coulomb blockade to control the flow of information and propose the computational process for analyzing these different situations.

5.1 Model Setup

(1) **Definition of Information Types:**

Fake News (F) and Accurate News (T) are considered as two types of information.

(2) **Agent Interaction Model:**

Agent interactions will have different energy barriers based on the type of information.

For Fake News, set the energy barrier between agents as B_{ij}^F to a high value.

For Accurate News, set the energy barrier as B_{ij}^T to a low value.

(3) **Probability Models for Information Exchange:**

For Fake News: $P_{ij}^F = e^{-\alpha B_{ij}^F}$

For Accurate News: $P_{ij}^T = e^{-\alpha B_{ij}^T}$

(1) **Initialization of Initial States:**

Set initial beliefs and tendencies for each agent regarding Fake News and Accurate News.

(2) **Information Exchange Simulation:**

Simulate information exchange between agents, including both Fake News and Accurate News.

The probability of information exchange depends on P_{ij}^F and P_{ij}^T as described above.

(3) **Verification of Spin Glass Phenomenon:**

When there is a division of opinions among agents, there is a possibility of spin glass states forming.

Spin glass states imply that agent opinions are frozen with local echo chambers forming.

Detect spin glass states by analyzing the correlation and coherence of agent opinions.

(4) **Results Analysis:**

Analyze how the fragmentation of Fake News flow leads to the occurrence of information fragmentation (spin glass states).

Observe how the fragmentation of Accurate News affects interactions between agents.

5.2 Implementation

To implement this model, you can use agent-based simulation tools. Each agent has its own beliefs and rules for information exchange, and these beliefs are updated over time. The results of the simulation can be analyzed by examining the distribution and changes in agent opinions, as well as the patterns of information flow.

5.3 Modeling Spin Glass Phenomenon in Social Sciences

When considering a general formula for applying the spin glass phenomenon to the context of social sciences, particularly in cases of opinion division and echo chamber formation, you need to model the interactions between agents and the dynamics of their opinions.

5.4 General Formula for Spin Glass Phenomenon

(1) **Agent Interaction Energy:**

The interaction energy between agents can be denoted as E_{ij}. It depends on the difference in opinions between agents i and j.

A general form is $E_{ij} = -J_{ij}s_is_j$, where s_i and s_j represent the opinions (spin states) of agents i and j, and J_{ij} is the strength of interaction between agents.

(2) **Total System Energy:**

The total energy of the system is represented as the sum of all interaction energies between agents: $E = \sum_{i<j} E_{ij}$.

(3) **Definition of Spin Glass State:**

A spin glass state can be defined as a situation where the system falls into multiple local minimum-energy states. This means that agent opinions are strongly interconnected, but the overall state is heterogeneous.

(1) **Initialization of Initial States:**

Assign random initial opinions (spin states) to each agent at $t = 0$.

(2) **Determination of Interaction Strengths:**

Decide the interaction strengths J_{ij} between agents, either randomly or based on specific rules. This can depend on the differences in opinions and methods of information transmission.

(3) **Calculation and Optimization of System Energy:**

Calculate the total energy of the system E and update agent opinions to minimize energy based on E_{ij}.

(4) **Detection of Spin Glass States:**

Analyze the patterns of agent opinions and detect the presence of multiple local minimum-energy states (spin glass states) over time.

In this model, it is expected that the flow of information and the formation of opinions exhibit complex dynamics similar to the spin glass physics model. Due to heterogeneous differences in opinions and varying strengths of interactions between agents, there may be a lack of overall coherence in the system, potentially leading to fragmentation and the formation of echo chambers.

For the scenario where filter bubbles within Coulomb blockade result in the occurrence of the spin glass phenomenon, we propose a time-stepped general formula. This model represents how the exchange of opinions evolves over time and how it influences the formation of filter bubbles and spin glass states.

5.5 Model Setup

(1) **Agent Interactions:**

Represent the strength of interaction for opinion exchange between agents as $J_{ij}(t)$.
Use the energy interaction based on the spin glass model: $E_{ij}(t) = -J_{ij}(t)s_i(t)s_j(t)$.
$s_i(t)$ and $s_j(t)$ represent the opinions (spin states) of agents i and j at time t.

(2) **Barriers to Information Exchange due to Coulomb Blockade:**

Represent barriers to information exchange between agents as $B_{ij}(t)$.
Define the probability of information exchange as $P_{ij}(t) = e^{-\alpha B_{ij}(t)}$.

(3) **Formation of Filter Bubbles:**

Observe the formation of filter bubbles as time progresses due to the increasing similarity in agent opinions and the rising barriers to information exchange.

5.6 Time-Stepped General Formula

(1) **Initialization of Initial States:**

Assign initial opinions to each agent at $t = 0$.

(2) **Updates Based on Time Steps:**

At each time step t, perform the following processes:

- **Information Exchange:** Attempt information exchange between agents, determining whether exchange occurs based on $P_{ij}(t)$.
- **Opinion Updates:** Update agent opinions based on interaction energy $E_{ij}(t)$.
- **Barrier Updates:** Update $B_{ij}(t)$ based on the type of information and the differences in agent opinions.

(3) **Occurrence of Filter Bubbles and Analysis of Spin Glass States:**

Observe the formation of filter bubbles over time and simultaneously analyze the development of spin glass states.

5.7 Considerations for Implementation

This model can be implemented using agent-based simulation.

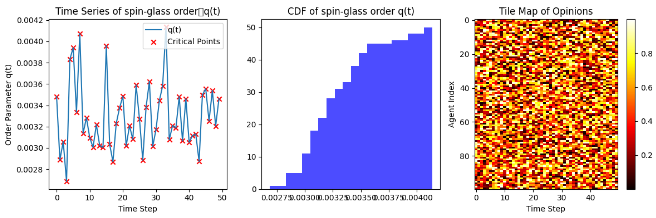

Fig. 7: spin-glass order q(t)

Opinion updates, barriers to information exchange, and the strength of agent interactions will dynamically change at each time step.

Detect the occurrence of filter bubbles and analyze the development of spin glass states by tracking the distribution and correlation of agent opinions over time.

The results show simulation results of opinion dynamics using the spin-glass model and analyze the time variation around critical points in the formation of filter bubbles and the diffusion state of news (fake news and correct news) in digital discourse.

5.8 Time series of spin glass order parameters

This graph plots the time variation of the spin glass order parameter q(t), which indicates the consistency of the agents' opinions. higher values of q(t) indicate agreement among the agents, while lower values indicate disagreement. Critical points (marked with a red x) indicate the time step at which the value of q(t) falls below a particular threshold (in this case, 0. Here it refers to the timestep below 01, which may represent a moment of reduced opinion consistency and increased opinion diversity. In this simulation, there is an overall trend of increasing consistency of opinion with a series of highs and lows, but frequent declines at critical points. This may indicate that opinions are temporarily dispersed in digital discourse and that filter bubbles are continually forming and dissolving.

5.9 CDF of the spin glass order parameter

The cumulative distribution function (CDF) of the spin glass order parameter q(t) shows the distribution of q(t) throughout the simulation. This CDF is skewed to the right, indicating that the order parameter takes low values at many time steps. This indicates that there are many states where there is diversity in agents' opinions, suggesting that the filter bubble is limited or temporary.

5.10 Tile map of opinions

The tile map shows the change in each agent's opinion over time. A lighter color means that the agent's opinion is closer to 1 (or agrees), while a darker color means that the agent's opinion is closer to 0 (or disagrees). The graph shows how opinions change over time, providing a visual representation of the diversity and dynamic change in opinions. This dynamic pattern shows that individual agents are sometimes in tune with the group and sometimes have different opinions, indicating that homogeneity of opinion within the filter bubble is not consistently established. The main insight gained from these graphs is that opinions are constantly changing in digital discourse. The filter bubble is a dynamic process that forms and dissolves over time, and we can see how both fake news and correct news generate this process. In other words, it is a spin-glass state that is being expressed.

6. The Spin Glass Phenomenon, where Filter Bubbles occur within Coulomb Blockade

In the context of the spin glass phenomenon, where filter bubbles occur within Coulomb blockade, we consider an applied model that takes into account time steps and various forces. These forces include frictional forces, resistance forces, and induction forces both inside and outside Coulomb blockade, influencing the evolution of agent interactions and their impact on filter bubble formation and spin glass states.

6.1 Agent Interactions

$$E_{ij}(t) = -J_{ij}(t)s_i(t)s_j(t) \tag{1}$$

Here, $s_i(t)$ and $s_j(t)$ represent the opinions of agents i and j at time t.

6.2 Barriers to Information Exchange (Coulomb Blockade)

$$P_{ij}(t) = e^{-\alpha B_{ij}(t)} \tag{2}$$

$B_{ij}(t)$ represents the barriers to information exchange between agents at time t.

6.3 Frictional and Resistance Forces

$$F_{ij}(t) \tag{3}$$

These forces represent obstacles to information flow and can vary based on differences in agent opinions and information quality.

6.4 Induction Forces

$$M_{ij}(t) \tag{4}$$

Induction forces symbolize the forces that attract agents to specific opinions or information sources.

6.5 Time-Stepped General Formula

At $t = 0$, each agent is assigned initial opinions and initial barrier values $B_{ij}(t)$.

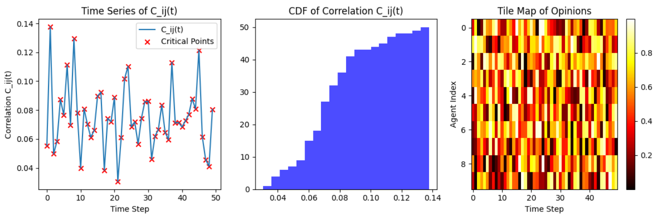

Fig. 8: spin-glass order Correlation)

6.6 Updates Based on Time Steps

At each time step t, the following processes are executed:

- Attempted Information Exchange
- Opinion Updates
- Consideration of Barriers and Frictional Forces
- Influence of Induction Forces

6.7 Analysis of Filter Bubbles and Spin Glass States

Over time, observe the formation of filter bubbles and analyze the development of spin glass states.

- This model can be implemented using agent-based simulation.
- Opinion updates, barriers to information exchange, frictional forces, resistance forces, and induction forces will dynamically change at each time step.
- Analyze the formation of filter bubbles and the development of spin glass states by tracking the distribution and correlation of agent opinions over time.

The results show correlations between agents' opinions and their changes over time to explore critical points related to the formation of filter bubbles and the spread of fake news and correct news in digital discourse.

6.8 Time series of correlations

This graph shows the time variation of the correlation coefficient of opinions among agents. A high correlation coefficient indicates similarity of opinion among agents, while a low value indicates diversity of opinion. The critical point is the time step at which the correlation falls below a certain threshold (0.5 in this case), indicating a period of significant divergence of opinion among the agents. The distribution of critical points in this graph suggests that the formation of the filter bubble is unstable or changing frequently. This dynamic state suggests that the spread of fake or correct news is not consistent across agents, and opinions may fluctuate without establishing the truth or falsity of the information.

6.9 CDF of Correlation

The cumulative distribution function of correlation coefficients shows the distribution of correlation coefficients over the entire simulation period; the shape of the CDF indicates that the correlation coefficients are distributed within a certain range and are not concentrated in certain high or low values. This indicates that the dispersion of opinions is within a certain range, suggesting that even if a filter bubble is formed, it is fluctuating rather than being stationary.

6.10 Tile Map of Opinions

The tile map of opinions of each agent over time visualizes the dynamics of opinions in terms of colors. The more intense the color change, the greater the change in opinion over time. The map shows that the uniformity of opinions does not continue, but changes significantly throughout time. This indicates that even if a filter bubble has formed, opinions continue to change within it, reflecting a state in which neither fake news nor correct news is consistently dominant.

In conclusion, what can be read from this graph is that the filter bubbles bubbles and the state of news dissemination are fluctuating over time. The correlation of opinions among agents is not consistent and shows a marked change at critical points. This variability suggests that the interaction and diffusion of fake and correct news is unstable, and how information is evaluated and accepted among agents may vary over time.

The color changes in the tile map indicate that agents' opinions fluctuate inconsistently, indicating that even when a filter bubble is formed, it is not in a fixed state and can easily change with the influx of new information and external influences. This dynamic change in opinion makes the analysis and understanding of opinion and information more complex in the digital discourse environment. The repeated creation and dissolution of filter bubbles necessitates further research into the mechanisms by which information is evaluated and diffused. In other words, it is a spin-glass state that is being expressed.

7. Conclusion:Energy of Interaction between Agents, Barriers to Information Exchange (Coulomb Blockade)

$$E_{ij}(t) = -J_{ij}(t)s_i(t)s_j(t)$$

7.1 Barriers to Information Exchange (Coulomb Blockade)

$$B_{ij}(t)$$
$$P_{ij}(t) = e^{-\alpha B_{ij}(t)}$$

Frictional and Resistance Forces

$$F_{ij}(t)$$
$$R_{ij}(t)$$

Induction Forces

$$M_{ij}(t)$$

Time-Stepped General Formula

Initialization of Initial States

At $t = 0$, assign initial opinions and initial barrier values $B_{ij}(t)$ to each agent.

Updates Based on Time Steps

At each time step t, execute the following processes:

Attempted Information Exchange

$$P_{ij}(t)$$

Opinion Updates

$$E_{ij}(t)$$

Influence of Frictional and Resistance Forces

$$F_{ij}(t)$$
$$R_{ij}(t)$$

Influence of Induction Forces

$$M_{ij}(t)$$

7.2 Analysis of Filter Bubbles and Spin Glass States

General Formula for Ultraviolet Divergence (UV Divergence)

$$D_{\mathrm{UV}}(t) = \lim_{k\to\infty} \sum_{i,j\in \mathrm{CB}} F_{ij}(k,t)$$

General Formula for FP Ghost (Faddeev-Popov Ghost)

$$G_{\mathrm{FP}}(t) = \sum_{i,j\in \mathrm{CB}} g_{ij}(t) B_{ij}(t)$$

General Formula for Indefinite Ghost

$$I_{\mathrm{indeterminate}}(t) = \sum_{i,j\in \mathrm{CB}} \delta_{ij}(t) V_{ij}(t)$$

General Formulas for Annihilation and Creation Operators

Annihilation Operator

$$a_{\mathrm{CB}}(t) = a(t) \cdot \theta(B_{\mathrm{CB}} - B(t))$$

Creation Operator

$$a^{\dagger}_{\mathrm{CB}}(t) = a^{\dagger}(t) \cdot \theta(B_{\mathrm{CB}} - B(t))$$

8. Coulomb Blockade's Causal Green's Function

$$G^{\mathrm{CB}}_{\mathrm{causal}}(t,t') = \theta(t-t')\theta(B_{\mathrm{CB}} - B_{ij}(t))[O(t), O(t')]$$

8.1 Advanced and Retarded Green's Functions Within Coulomb Blockade

Retarded Green's Function

$$G^{\mathrm{CB}}_{\mathrm{retarded}}(t,t') = \theta(t-t')\theta(B_{\mathrm{CB}} - B_{ij}(t))[O(t), O(t')]$$

8.2 Annihilation and Creation Operators Within Coulomb Blockade

Annihilation Operator

$$a^{\mathrm{CB}}_i(t) = a_i(t) \cdot \theta(B_{\mathrm{CB}} - B_{ij}(t))$$

Creation Operator

$$a^{\dagger\mathrm{CB}}_i(t) = a^{\dagger}_i(t) \cdot \theta(B_{\mathrm{CB}} - B_{ij}(t))$$

The results show the results of a simulation dealing with information exchange between agents, its barriers, and information ambiguity. The graphs are intended to analyze the formation of filter bubbles in digital discourse and the associated changes in Coulomb blockage (rigidity of opinion) over time. Below is a discussion of each graph.

8.3 Ultraviolet (UV) Divergence Time Series

UV divergence shows the divergence caused by the intensity of the information exchange being divided by a small value of epsilon. Peaks of divergence in the time series data are marked as critical points (marked with a red X), which may indicate extreme instability or discrepancies in the information exchange. Such critical points may capture moments of pronounced rigidity of opinion during the formation of filter bubbles.

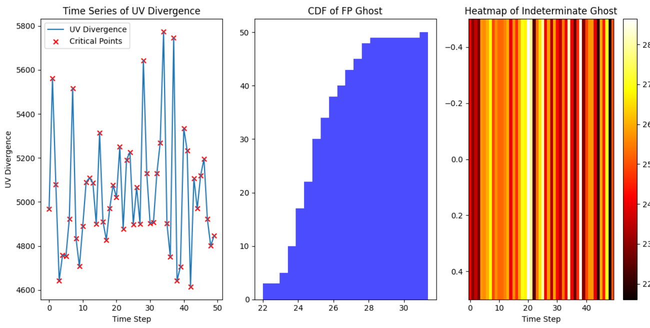

Fig. 9: Series of FP Ghost / UV Divergence / Indeterminate Ghost Results

8.4 CDF of FP (Fixed Point) Ghost (CDF of FP Ghost)

The FP Ghost is calculated by the product of the intensity of information exchange and the barriers to information exchange, and captures the impact of information flow and its barriers; the CDF shows the cumulative distribution of the FP Ghost over all time steps, although it indicates that the FP Ghost is low at most time steps, increases markedly at certain points. This indicates that the diversity of opinions may temporarily increase as information exchange increases at certain timesteps. 3.

8.5 Heat Map of Indeterminate Ghosting

The indeterminate ghost is calculated as the product of information ambiguity and barriers to information exchange, and shows the extent to which barriers are affected by information uncertainty. The heatmap shows these values for each time step, with the vertical axis constant (since only a single row is shown) and the time step varying along the horizontal axis. Darker colors indicate lower values of indefinite ghosting and brighter colors indicate higher values. From this graph, it can be read that the indefinite ghosting values do not vary significantly over time, but rather vary within a certain range. This may mean that opinion rigidity and the formation of filter bubbles persist at a constant level regardless of the uncertainty of the information.

Overall, these graphs suggest that filter bubble formation and opinion rigidity are dynamic processes, and that information uncertainty and barriers to exchange play an important role. The UV divergence critical points capture the sudden changes and instability that occur in the process of information exchange, which may correspond to the moment of a filter bubble or the bursting of an existing bubble; the FP ghost CDFs capture the relationship between information flow and barriers through time, and the uncertainty The heatmap of the quantitative ghosting shows persistent information uncertainty. These metrics are useful for understanding filter bubbles and opinion rigidity.

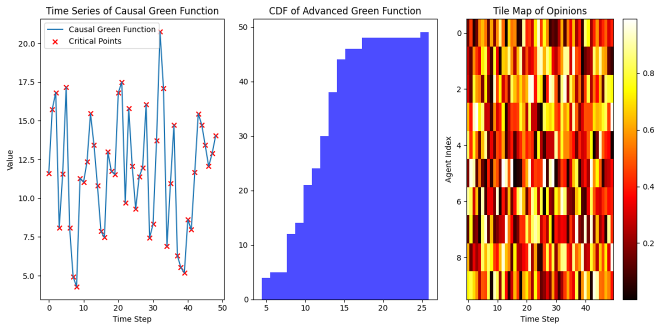

Fig. 10: Series of Retarded Advanced Green Function, Causal Green Function Results

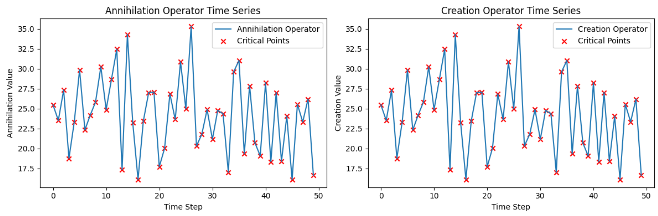

Fig. 11: Creation Operator / Annihilation Operator Time Series

These metrics serve as indicators for understanding filter bubbles and opinion rigidity, and provide insight into the mechanisms of information diffusion and acceptance. In particular, the critical point of UV divergence is useful for identifying conditions and timing when opinion rigidity is likely to occur. The distribution of FP ghosts shows how much barriers to information exchange affect opinion formation, while indefinite ghosts indicate how information uncertainty affects agents' opinions.

This analysis allows us to monitor the diversity of opinions and patterns of information diffusion in digital discourse and to develop strategies for understanding the dynamics of the formation and dissolution of filter bubbles. Monitoring these dynamics is critical because the formation of filter bubbles makes it more difficult to distinguish between fake and correct news and increases the risk of spreading misinformation.

The two graphs above show time series of causal Green's functions, cumulative distribution functions (CDF) of advanced Green's functions, tile maps of opinions, and time series of extinction and generation operators. These are related to the rigidity of opinions in digital discourse, or Coulomb closure states. A discussion based on each of these graphs follows.

8.6 Time Series of Causal Green's Functions

The causal Green's function shows the correlation of agents' opinions between time t and t+1, reflecting causality (relationships along the time stream). Peaks in the time series (points marked by critical points) indicate a state of strong correlation of agents' opinions at a particular point in time, which may represent moments when filter bubbles form and rigidity of opinions becomes more pronounced.

8.7 CDF of the Advanced Green's Function

The CDF of the advanced Green's function shows the cumulative distribution of opinion correlations over the entire time step. This distribution shows that opinion correlations are highly variable over the entire time step, suggesting that opinions are dynamically changing without rigidity.

8.8 Tile Map of Opinions

The tile map shows in colors how the opinions of different agents change over time. This tile map shows that opinions vary widely over time, with no consistent pattern. This indicates that agents are updating their opinions based on new information in digital discourse and that no rigidity of opinion may be occurring.

8.9 Time Series of Extinction and Generation Operators

Time series of extinction and generation operators represent states in which opinions are decreasing (extinction) and increasing (generation). Critical points in these time series indicate time steps at which changes in opinion become more pronounced and may indicate the formation or dissolution of filter bubbles or changes in opinion rigidity.

These observations suggest that opinion rigidity in digital discourse is highly dynamic and that opinions continue to evolve over time. The formation of filter bubbles is likely to be temporary, with agents updating their opinions in response to new information and influences from other agents. Critical points indicate the time steps at which certain changes are concentrated in this dynamic process, indicating that changes in opinion are particularly strong at these points.

In particular, the time series of causal Green functions and extinction/generation operators capture the correlation of opinions and their changes at successive time steps, providing insight into the mechanisms by which filter bubbles form and opinions become more rigid. These functions and operators could be observed to quantify how opinions diffuse, aggregate, and also disappear along time.

This information is important for understanding the flow of information in digital discourse and for assessing the impact of filter bubbles. The identification of critical points helps to identify states in which opinions may be fixed and, conversely, in which a diversity of opinions may emerge. Through this analysis, it is possible to develop strategies to prevent opinion rigidity and to plan interventions to reduce the filter bubble.

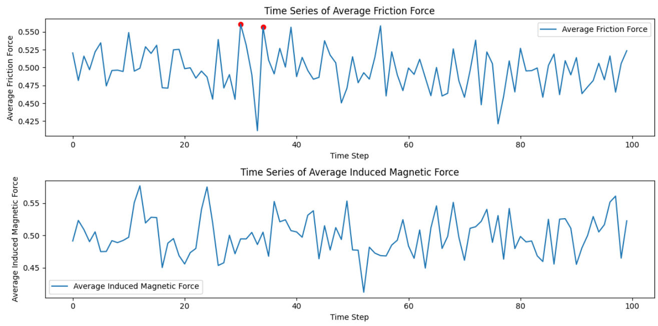

Fig. 12: Frictional and Induced Magnetic Forces

9. Conclusion:Considering Time variation of frictional force

The results show the time variation of the mean values of frictional force and induced magnetic force, which may serve as indicators for analyzing Coulomb blockage (opinion rigidity) during the formation of filter bubbles in digital discourse.

9.1 Time variation of frictional force

Frictional force may indicate barriers or resistance in the exchange of opinions among agents. The graph shows overall variation, with large peaks or critical points (red dots) at specific time steps. These peaks may represent times when barriers in opinion exchange temporarily increase, indicating moments of potential opinion rigidity.

9.2 Time Variation of Induced Magnetic Forces

The induced magnetic forces may represent the degree to which opinions among agents influence each other. The graph here also fluctuates, with critical points observed at specific time steps. This may represent a time when the interaction of opinions among agents increases before opinion rigidity occurs.

The occurrence of a critical point captures the moment when the fluidity of opinion changes rapidly and may be an indicator of the formation or collapse of a filter bubble. Opinions tend to homogenize within the filter bubble, but changes in frictional and induced magnetic forces indicate that this homogenization is not stable and fluctuates with time. The critical point underscores the dynamic nature of the bubble, suggesting that it may change with the diversity of opinions and the introduction of new information.

This analysis shows that the process of opinion formation in digital discourse is highly complex, and that the intensity of interaction between agents and barriers to opinion exchange play an important role. These metrics provide useful insights in developing strategies to mitigate opinion rigidity and prevent the formation of filter bubbles. For example, interventions that reduce barriers to opinion exchange at times

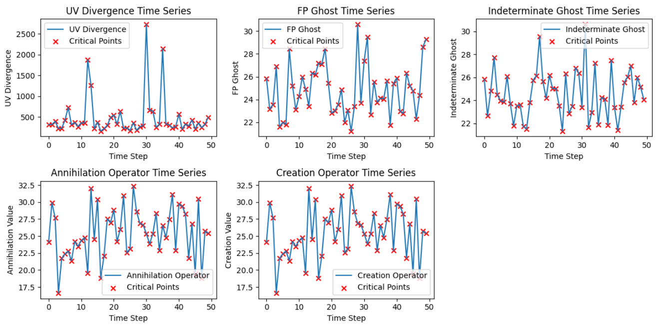

Fig. 13: Identification of critical points during spin glass condition

of heightened frictional forces or the introduction of diverse information at moments of heightened induced magnetism would be advisable to prevent homogenization of opinion and to validate the promotion of a healthier digital speech environment.

10. Conclusion:Identification of critical points during spin glass condition

The results show time series of ultraviolet (UV) divergence, fixed point (FP) ghosting, indefinite ghosting, annihilation operators, and creation operators in the simulation, each associated with a Coulomb occlusion state (rigidity of opinion). These indicators analyze the diffusion state of fake and correct news during the onset of the filter bubble.

10.1 Ultraviolet (UV) Divergence Time Series

UV divergence indicates extreme heterogeneity and instability during information exchange, and high values, especially at critical points (red 'x' marks), may indicate moments when opinion exchange is particularly active. These peaks may be associated with moments of filter bubble formation or dissolution, or moments of opinion rigidity.

10.2 Fixed Point (FP) Ghost Time Series

FP ghosts reflect the impact of barriers to opinion exchange. In time series data, a spike in values at critical points may indicate that opinion exchange is significantly restricted at a particular moment. This may point to a process of homogenization of opinions among agents and the formation of a filter bubble. The fluctuations in FP ghosting also suggest that rigidity of opinion is underway within the filter bubble.

10.3 Time series of indefinite ghosting

The indefinite ghosting indicates how information uncertainty and ambiguity affect barriers to opinion exchange. This value, which varies over time, may indicate the degree to which agents are open to, or resistant to, new information and different opinions. Increases or decreases in value at critical points indicate important changes in opinion rigidity or the formation of filter bubbles.

Time Series of Extinction and Generation Operators Extinction operators represent states of decreasing opinion, while generation operators represent states of increasing opinion. Critical points in these graphs indicate moments of opinion flux or change and are indicators of how an agent's opinion is changing at a particular time. A moment when an opinion disappears could mean that one opinion is no longer dominant or is replaced by new information. On the other hand, moments when opinions are generated could indicate that new information or opinions are beginning to spread. These fluctuations may reflect changes or updates in opinions within the filter bubble, suggesting that the bubble is not in a fixed state.

Analysis from these graphs provides insight into the dynamics of information flow and opinion formation in digital discourse. The process of forming and dissolving filter bubbles is highly complex, and these data are of great value in developing interventions to prevent opinion rigidity and strategies to promote healthy public discourse. Understanding the dynamic nature of filter bubbles is essential to preventing the spread of misinformation and at the same time maintaining an environment where diverse opinions can coexist.

10.4 Challenges in the hypothetical methodology of this study

Static analysis of data is needed, and the current analysis provides a static snapshot of time series data, which may not be sufficient to fully capture dynamic processes Also, distinguish between correlation and causation: correlation derived from time series data is not directly indicative of causation. They may lead to erroneous causal relationships. 3. And multidimensional data must also be handled: opinion formation is a multidimensional process, and current analyses may not fully represent this complexity.

10.5 Prospects for this paper

Introduce dynamic systems modeling and further model opinion formation as a dynamic system to introduce a deeper understanding of the mechanisms of opinion change, as well as real-time data analysis: real-time data from social media platforms to track opinion change in Real-time data analysis: real-time data can be obtained from social media platforms to track changes in opinion in real-time. 3. Second, the use of multi-agent simulation: multi-agent models can be used to simulate more complex opinion exchange dynamics.

Machine learning and predictive modeling, for example, can also be introduced, applying machine learning to time series analysis to build models that predict future changes in opinion. We surmise that hidden Markov models and recurrent neural networks are effective for this. It would also be good to model the relationships between agents as a network to enhance network analysis and analyze how the topology of the network affects the rigidity of opinions. Finally, we introduce causal inference, going one step further from correlation and using causal inference techniques to assess what causal effect a particular event or intervention has on opinion change. Possible methods include Granger causality tests and structural equation modeling. 4. Refinements of agent-based modeling will also be added, using multi-agent simulation to make the interaction rules between agents more complex and mimic real social effects. This could generate more realistic scenarios based on psychological and social mechanisms that cause agents to change their opinions. In addition, by applying system dynamics and incorporating elements of system dynamics, such as feedback loops and time delays, the process of opinion rigidity and filter bubble formation can be analyzed in more detail.

Also, integrating sentiment analysis during filter bubble formation: incorporating sentiment analysis from textual data allows for a deeper understanding of opinion change, taking into account the emotional component behind the opinion. Their model validation and parameter estimation: adjust the parameters of the simulation model using real data to verify how well the model's predictions match real-world data These methods would be necessary a more accurate understanding of filter bubbles and opinion rigidities, forecasts, and ultimately a fine introduction of policymaking and interventions aimed at mitigating or managing these phenomena.

Aknowlegement

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