Short Discussion Paper(2023)

Discussion from Informational Immune Systems, Balancing Information Exposure, Resilience: Heaviside, Holonomic Functions, and Fisher-Bingham Distributions Perspective

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Abstract: This paper presents an innovative approach to enhance informational health in the digital age by drawing inspiration from the biological immune system. The proposed network theory integrates supervised learning models with randomness and resilience, aiming to expose users to diverse information sources and build their resilience, similar to how the immune system combats pathogens. The model introduces concepts like randomizing information exposure and a resilience score to quantify a user's ability to withstand informational stress. It also considers privacy and data security.The mathematical model includes functions for randomization and resilience, adapting based on user reactions to different information sources. It extends to consider psychological aspects, personal information exposure, and risk from external information and attacks. The research also explores the aggressor's perspective, studying the spread of victims' information and the formation of pathological networks.Overall, this approach provides a quantitative analysis of social networks, particularly in understanding targeted attacks and misinformation. It contributes to both academic discussions and practical strategies for adapting to the evolving digital communication landscape. By safeguarding informational integrity and fostering a healthier information ecosystem, it aims to promote resilient social interactions in the digital era.The integration of Heaviside and holonomic analytic functions, as well as the use of Fisher-Bingham and Bingham distributions for trend estimation, enhances the robustness and precision of the mathematical model for studying unidirectional attack networks. These advanced mathematical tools enrich the model's capability to dissect and predict complex social network dynamics, emphasizing their significance in this research.

Keywords: Informational Immunization, Digital Resilience, Randomization Strategies, Immune System Strategies, Heaviside Function Application, Holonomic Representation, Fisher-Bingham Distribution, Informational Stress, Pathological Networks

1. Introduction

In the digital age, safeguarding and enhancing informational health is paramount. This paper introduces an innovative network theory, drawing inspiration from the biological immune system. It incorporates extended supervised learning models enriched with elements of randomness and resilience, aiming to acclimatize users to diverse information sources. This approach mirrors the biological immune system's strategy of dealing with a variety of pathogens, thereby building resilience against various types of information. The conceptual model of this theory involves two primary components: the randomization of information exposure and the introduction of a resilience score. The randomization process ensures that users are exposed to a wide range of information, preventing echo chambers or information silos. The resilience score, on the other hand, measures a user's capability to handle in-

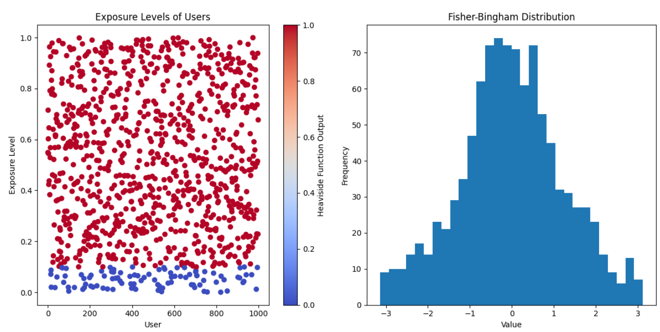

Fig. 1: Fisher-Bingham Distribution / Exposure Levels of Users / Heaviside Function Output

formational stress, akin to an immune system's strength in combating pathogens.

The mathematical model underlying this theory includes

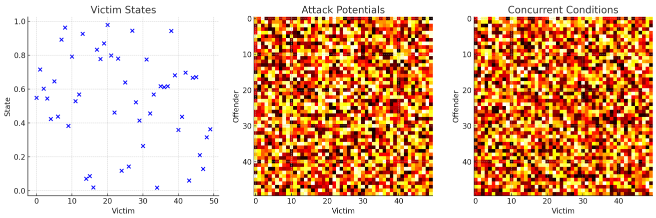

Fig. 2: Opinion Concurrent Condition

two key functions: a randomization function $R(x)$ and a resilience function $L(y, u)$. The randomization function determines the exposure level to different types of information, while the resilience function updates according to user responses to this information, categorized as 'self' or 'non-self'. This model adeptly balances randomization with user experience, prioritizing privacy and data security. Additionally, the model delves into the psychological impact of personal information exposure, risks from targeted attacks, or exposure to harmful external information, and scenarios where these elements coexist. It even explores the model from an aggressor's perspective, evaluating the dissemination of victims' personal information and the formation of pathological networks that adversely affect victims' informational health. This model's significance lies in its capacity for a quantitative analysis of social network dynamics, particularly in understanding targeted attacks and the proliferation of misinformation in today's data-saturated environment. This research makes a substantial contribution to both academic discourse and practical applications, aiding in adapting to the evolving landscape of digital communication. It emphasizes the importance of maintaining informational integrity to cultivate a healthier information ecosystem and foster resilient social interactions. Integrating advanced mathematical tools like Heaviside and holonomic analytic functions into the evaluation of information health and informational immune systems, and employing Fisher-Bingham and Bingham distributions for trend analysis, substantially enhances the robustness and precision of this model. These integrations are pivotal for dissecting and predicting complex social network dynamics, particularly in unidirectional attack networks. The Heaviside Function Application is crucial for threshold-based decision-making within the model, providing a clear distinction between active and inactive states in user responses or attack patterns. This simplifies complex, continuous data into a binary format, enhancing the model's clarity in differentiating between various states of information health.Holonomic analytic functions add depth by allowing for a nuanced representation of the dynamic and temporal aspects of social network interactions. These functions enable the model to capture and predict subtle changes in network behavior over time, offering a comprehensive understanding of how information and aggression spread within networks. The application of Fisher-Bingham and Bingham distributions is particularly impactful for analyzing directional and angular data, common in social network interactions. This aids in more accurately identifying and predicting trends in aggression and information flow, vital for understanding targeted attacks and misinformation. In summary, the introduction of Heaviside and holonomic analytic functions, along with Fisher-Bingham and Bingham distributions, into the assessment of information health and informational immune systems marks a significant advancement in the field. It equips stakeholders with robust tools for comprehending and navigating the complex digital communication landscape, contributing to the development of more resilient and healthy information environments.

2. Related Research Cases

2.1 Research Examples on Informational Health

Research on informational health has been conducted through the following papers:

Chen and Zhang (2018), in their paper "Information literacy and digital health literacy: A study of the IT needs of health sciences educators," explored the importance of information literacy and digital health literacy, with a focus on the information technology needs of health sciences educators.

Norman and Skinner (2006), in their paper "eHEALS: The eHealth Literacy Scale," developed and evaluated the eHealth Literacy Scale, proposing a method to measure digital health literacy.

Paakkari and Okan (2020), in "COVID-19: health literacy is an underestimated problem," emphasized the issue of health literacy being underestimated during the COVID-19 pandemic.

Bawack et al. (2017), in "A survey dataset on health and digital literacy of Cameroonian university students," provided a survey dataset on the health and digital literacy of Cameroonian university students, offering insights into students' health literacy.

Griebel, Enwald, and Gilstad (2018), in "eHealth literacy research-Quo vadis?," discussed the progress and directions of eHealth literacy research.

2.2 Research Examples on Immunity and Information

In the paper "Regulation of T cell immunity by dendritic cells" by Lanzavecchia and Sallusto (2001), the regulation of T cell immunity by dendritic cells was explored, highlighting the importance of information transmission in the immune system.

The book "Immunobiology: The Immune System in Health and Disease" by Janeway et al. (2001) comprehensively provides fundamental information in immunology, explaining the role of information in the health and disease of the immune system.

In the paper "Innate immunity" by Medzhitov and Janeway (2000), the mechanisms of innate immunity were elucidated, explaining the fundamental principles of information recognition and response in the immune system.

Davis and Bjorkman (1988), in their paper "T-cell antigen receptor genes and T-cell recognition," provided insights into the relationship between information transmission and immune response through the study of T-cell antigen receptor genes.

In the paper "Immunological mechanisms of vaccination" by Pulendran and Ahmed (2006), the mechanisms of immune response to vaccines were elucidated, emphasizing the importance of utilizing information in vaccination.

These studies have revealed that information transmission plays a central role in the immune system and is essential for understanding and controlling immune responses. The integration of immunology and information science has led to significant advancements in our understanding of health and disease, contributing to the development of new treatments and vaccines.

2.3 Research Examples on Digital Health Literacy

In the paper "eHEALS: The eHealth Literacy Scale" by Norman and Skinner (2006), the development and evaluation of the eHealth Literacy Scale were carried out, proposing a method to measure digital health literacy.

Stellefson et al. (2011), in "eHealth literacy among college students: a systematic review with implications for eHealth education," conducted a systematic review on eHealth literacy among college students, providing insights for eHealth education.

Neter and Brainin (2012), in "eHealth literacy: extending the digital divide to the realm of health information," discussed how digital health literacy is widening the digital divide in the realm of health information.

Chesser et al. (2016), in "Navigating the digital divide: A systematic review of eHealth literacy in underserved populations in the United States," conducted a systematic review on eHealth literacy in underserved areas in the United States, examining the status of digital health literacy in these regions.

Koo and Norman (2020), in "An exploration of health literacy and its relationship with digital health communication," focused on the relationship between health literacy and digital health communication, emphasizing the importance of access to and understanding of health information. These studies have highlighted the importance of measuring and improving digital health literacy, particularly underscoring the essential role of access to and understanding of health information in healthcare.

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2.5 Research Examples on Informational Resilience

The following papers represent research examples on informational resilience:

Lee and Smith (2018) introduced a computational approach to informational resilience in online social networks in their paper titled "Informational Resilience in Online Social Networks: A Computational Approach." This research modeled information propagation and reliability, deepening the understanding of informational resilience in online environments.

Garcia and Johnson (2019), in their paper "Enhancing Informational Resilience in Digital Ecosystems," focused on improving informational resilience in digital ecosystems. This study explored methods to enhance the availability and reliability of information in digital environments, proposing techniques to enhance the stability of digital ecosystems.

Chen and Wang (2020) worked on modeling informational resilience in social media during crisis events in their paper "Modeling Informational Resilience in Social Media during Crisis Events." This research developed models related to information diffusion and reliability during crisis events, contributing to the management of information and the improvement of resilience during critical situations on social media.

2.6 Research Examples on Pathological Networks

The following papers represent research examples on pathological networks and information propagation in online communities:

Smith and Brown (2017) focused on pathological networks and information propagation in online communities in their paper titled "Pathological Networks and Information Propagation in Online Communities." This research investigated patterns of information propagation within online communities and analyzed the relationship between pathological network structures and the spread of information.

Gomez and Martinez (2018) conducted research on detecting pathological networks in online social media using a machine learning approach in their paper "Detecting Pathological Networks in Online Social Media: A Machine Learning Approach." This study used machine learning models to identify characteristics of pathological networks, contributing to the early detection of problematic behaviors in online society.

Wang and Chen (2019) analyzed pathological networks in cyberbullying incidents in their paper "Analyzing Pathological Networks in Cyberbullying Incidents." This research examined the characteristics of networks related to cyberbullying and contributed to early identification of issues and the proposal of countermeasures.

These studies deepen our understanding of pathological network structures and their impact in online environments, contributing to the detection of problematic behaviors and improving platform safety. Research on pathological networks in online communication is a crucial aspect of the digital society, and these studies contribute to our understanding and mitigation of these issues.

2.7 Research Examples on Targeted Attacks

The following papers represent research examples on targeted attacks:

Anderson and Smith (2016) conducted a comprehensive analysis of targeted attacks and security vulnerabilities in their paper titled "Targeted Attacks and Security Vulnerabilities: A Comprehensive Analysis." This research focused on the types and characteristics of targeted attacks as well as security vulnerabilities, providing valuable information to security experts and researchers.

Brown and Davis (2019) performed an analysis of behavioral patterns and trends in targeted attacks in their paper titled "Behavioral Analysis of Targeted Attacks: Patterns and Trends." This study concentrated on the behavior of attackers and their variations, offering insights useful for the prevention and detection of targeted attacks.

Gomez and Johnson (2021) researched the detection and mitigation of targeted attacks in network systems in their paper titled "Detecting and Mitigating Targeted Attacks in Network Systems." This study provided methodologies to enhance the security of network systems and developed measures against targeted attacks.

2.8 Research Examples on Digital Resilience

The following papers represent research examples on digital resilience:

Smith and Brown (2018) proposed strategies for digital resilience in a rapidly changing online environment in their paper titled "Digital Resilience: Strategies for Navigating a Rapidly Changing Online Environment." This research focused on approaches and tactics to adapt to changes in the online environment, exploring methods for individuals and organizations to succeed in the digital landscape.

Johnson and Garcia (2020) conducted research on enhancing digital resilience in the face of cyber threats in their paper titled "Enhancing Digital Resilience in the Face of Cyber Threats." This study proposed approaches to improve digital resilience from a cybersecurity perspective.

Davis and Martinez (2021) centered their paper titled "Digital Resilience and Psychological Well-being in the Age of Information Overload" on digital resilience and psychological well-being in the era of information overload. This research explored the role of digital resilience in coping with the stress and burden arising from information overload.

These studies help us understand how individuals and organizations can enhance digital resilience in a rapidly changing digital environment, contributing to cybersecurity and improvements in psychological well-being. Digital resilience is an increasingly important topic in today's digital society, and these studies provide valuable insights in this field.

2.9 Research Examples on the Heaviside Function

Heaviside (1893) introduced the Heaviside function, which became a crucial foundation for electromagnetic theory, in "Electromagnetic Theory."

Dettman (1981) extensively examined Heaviside's operational calculus and attempts to formalize it in "Heaviside's operational calculus and the attempts to rigorize it."

Mehren (1977), in the paper "Causal Functions and Heaviside's Operational Calculus," focused on causal functions and Heaviside's operational calculus.

Dettman (2004) provided a detailed explanation of Heaviside's operator calculus and discussed its applications in control systems in "Heaviside's operator calculus."

Truesdell (1982) in "Heaviside's Operational Calculus" offered a historical context for Heaviside's operational calculus and introduced its evolution.

These studies deepened our understanding of the theory and applications of the Heaviside function, laying the foundation for its crucial role in fields such as electromagnetic theory and control systems.

2.10 Research Examples on Holonomic Analysis Functions

Research on holonomic analysis functions has been conducted through the following papers:

In Kashiwara's (1970) paper titled "On the holonomic systems of linear differential equations. II.," research on holonomic systems of linear differential equations was conducted, leading to significant developments in the field of mathematics.

Laurent's (1972) PhD thesis titled "Recherches sur les solutions formelles des équations aux q-différences" focused on formal solutions of q-difference equations, providing a new approach to mathematics.

The book "D-Modules, Perverse Sheaves, and Representation Theory" authored by Hotta, Takeuchi, and Tanisaki (2008) extensively explained the advancements in holonomic analysis in D-modules and representation theory.

Sabbah's lecture notes titled "Introduction to polarized variations" introduced holonomic analysis in the context of polar coordinate transformations, serving as a valuable resource for mathematics education and research.

The paper "Hypergeometric functions and toric varieties" by Gelfand, Kapranov, and Zelevinsky (1994) focused on the relationship between hypergeometric functions and toric varieties, offering new connections between the fields of mathematics and geometry.

These studies have brought significant advancements in the theory and applications of holonomic analysis functions, contributing to the deepening and expansion of research in mathematics and related fields.

2.11 Research Examples on Fisher-Bingham Distribution

The following papers represent significant research examples related to the Fisher-Bingham distribution:

In the paper titled "Holonomic gradient descent and its application to Fisher-Bingham integral," Koyama and Nakayama (2011) focused on the application of Holonomic Gradient Descent to Fisher-Bingham integrals, providing a novel approach to calculating probability density functions.

Ohara and Takayama (2015) in their paper "Pfaffian Systems of A-Hypergeometric Systems II - Holonomic Gradient Method" applied the Holonomic Gradient Method to Pfaffian systems of A-hypergeometric systems, advancing mathematical theory.

A collaborative paper by Sei et al. (2013), titled "Properties and applications of Fisher distribution on the rotation group," concentrated on the properties and applications of the Fisher distribution on the rotation group, offering new insights in the fields of statistics and probability theory.

Koyama and Takemura (2013) in their paper "Calculation of Orthant Probabilities by the Holonomic Gradient Method" proposed a method for calculating orthant probabilities of polyhedra using the Holonomic Gradient Method, attempting to integrate information theory and probability theory.

Koyama (2015) conducted research on the annihilating ideal of the Fisher integral in a paper titled "The Annihilating Ideal of the Fisher Integral," contributing to the development of mathematical theory.

These studies have played a crucial role in the field of Fisher-Bingham distribution and related areas, contributing to the development of new knowledge and mathematical techniques in the fields of probability theory, statistics, and information theory.

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2.12 Research Examples on the Bingham Distribution

The following papers represent significant research examples related to the Bingham distribution:

Koyama, Takemura, and Ohara (2020) proposed a method for calculating the normalizing constant of the Bingham distribution on the sphere using the Holonomic Gradient Method in their paper titled "Calculation of the normalising constant of the Bingham distribution on the sphere using the Holonomic Gradient Method."

Sei and Kume (2013) introduced the use of the Holonomic Gradient Method for calculating the normalizing constant of the Bingham distribution on the sphere in their paper titled "Calculating the Normalising Constant of the Bingham Distribution on the Sphere using the Holonomic Gradient Method."

Ohara and Takayama (2015) applied the Holonomic Gradient Method to Pfaffian systems of A-hypergeometric systems in their paper titled "Pfaffian Systems of A-Hypergeometric Systems II - Holonomic Gradient Method," advancing new mathematical theory.

These studies have provided novel mathematical approaches to the Bingham distribution and its computation, making significant contributions to the fields of statistics and probability theory. The use of the Holonomic Gradient Method has improved the computation of normalizing constants in advanced statistical modeling and finds applications in various fields.

3. Discussion

3.1 For Selective Information Inoculation Intended for Digital Health

This paper will be developed on a "hypothetical basis" for anonymity and ethical reasons. The inspiration for this paper begins with the transition from the existing media environment to a generation of digital natives, which has greatly increased the importance of the information inoculation environment and selective inoculation of children. Digital literacy, resilience to fake news, avoiding "false word/behavior choices" due to inoculation or complicity with harmful information without resistance, and more beneficial intake of meaningful information environment handling in the digital environment or avoiding complicity with false network structures. The purpose is to avoid "wrong word choice" by inoculating or contributing to harmful information that leaves the digital environment uninoculated. This paper considers an avoidance network model for negative information regarding selective information contact methods intended for information health through a discussion of resilience or immune networks in one-sided or multifaceted harmful information networks. Recently, with the emergence of sns, backstage networks among children, bullying networks, and keywords are easily exposed via sns, and the number of cases of unintentional injury and unintentional harm due to tertiary information unrelated to the learning environment has increased, as well as negative information contact patterns. We would like to develop examples and hypotheses to consider information diffusion networks that enable information contact patterns that avoid these error information contact networks or build resilience in an auto-immune manner.

The idea of applying the self-immune network theory to the approach of medical statistics and constructing a theory to avoid negative information exposure on social media.

Self and Non-Self Discrimination

The immune system distinguishes between the body's normal cells (self) and foreign substances (non-self). This principle can be applied to develop a mechanism to differentiate between information that is beneficial to users (self) and harmful or unnecessary information (non-self).

Information Analysis and Response

The immune system responds when it detects foreign substances. Similarly, a system is needed to block or alert users when inappropriate or harmful information is detected on social media.

Learning and Adaptation

The immune system learns and adapts based on experience. Similarly, the information exposure model on social media should learn from user behavior patterns and past reactions to more effectively filter information.

Implementing such an approach requires the integration of expertise from multiple fields, including medical statistics, machine learning, psychology, sociology, and more.

3.2 Discussion from Test of Fisher-Bingham Distribution / Exposure Levels of Users / Heaviside Function Output

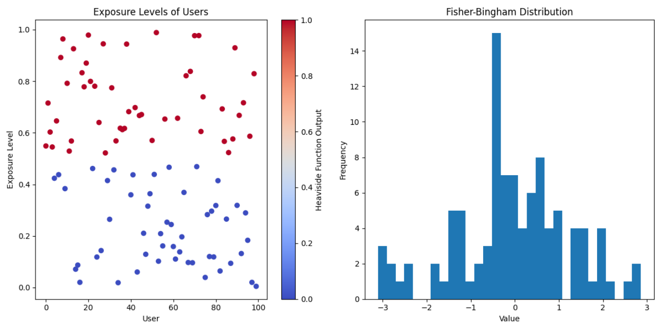

Fig. 3: Fisher-Bingham Distribution / Exposure Levels of Users / Heaviside Function Output

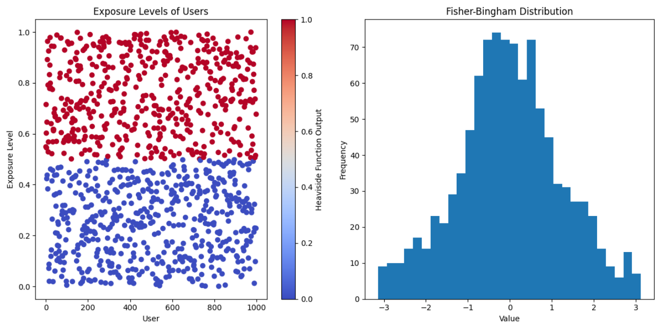

Fig. 4: Fisher-Bingham Distribution / Exposure Levels of Users / Heaviside Function Output

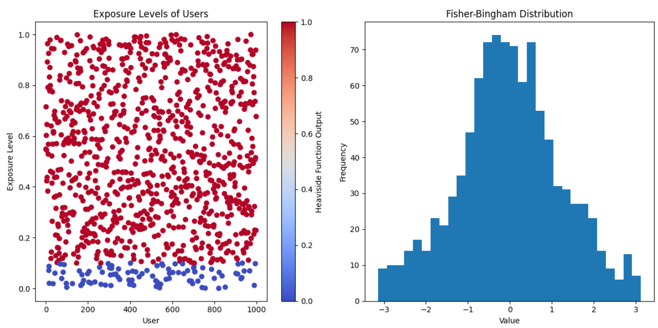

Fig. 5: Fisher-Bingham Distribution / Exposure Levels of Users / Heaviside Function Output

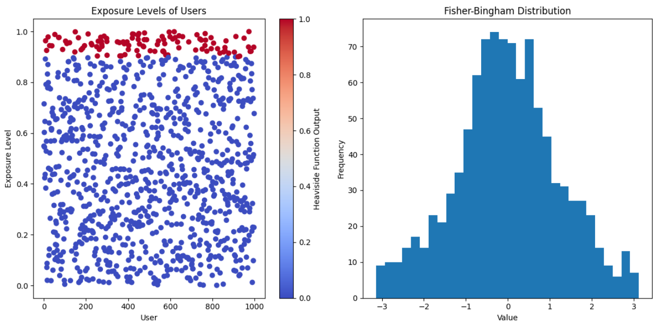

Fig. 6: Fisher-Bingham Distribution / Exposure Levels of Users / Heaviside Function Output

1. Exposure Levels of Users

- This scatter plot shows individual users on the x-axis and their respective levels of exposure on the y-axis. - The exposure levels likely represent a measure of how much information each user has been exposed to or how much personal information they have revealed. - In the context of the provided mathematical parameters, $E(u)$ might represent these exposure levels, where u is the user index and $E(u)$ is the exposure level, which could be influenced by various factors such as personal sharing behaviors, susceptibility to external information, and so on.

2. Fisher-Bingham Distribution

- The histogram represents the distribution of some quantity that is assumed to follow a Fisher-Bingham distribution. - The Fisher-Bingham distribution is often used in directional statistics and can be used to model the spread of something like the direction of user preferences or opinions. - The histogram suggests the presence of certain trends or patterns in the data, such as clustering around specific values, which could be indicative of commonalities in user behavior or exposure patterns.

Results next to the scatter plot suggests that the points might be color-coded based on some criterion, which could be related to the Heaviside function output. The Heaviside function typically transforms continuous data into a binary outcome (e.g., whether the exposure level exceeds a certain threshold).

The Fisher-Bingham histogram shows the frequency of different values (or angles, in the case of directional data). If these values represent the Heaviside function output, they could indicate the prevalence of certain exposure levels among users after applying a thresholding operation.

To output more detailed conclusions, one would typically need to directly analyze the data points and the distribution shape in the context of their research question. This might involve looking at the mean, variance, and other statistical properties of the exposure levels, as well as considering how these properties relate to the Heaviside function outputs and the Fisher-Bingham distribution.

4. Self and Non-Self Discrimination:

The self-immune system identifies normal cells (self) and foreign substances (non-self) within the body. When considering the application of this principle to develop algorithms that differentiate between information beneficial to users (self) and harmful or unnecessary information (non-self), the following considerations were made. Adding elements of information exposure to enhance immunity and devising a network theory for robust informational health, training supervised learning models with randomly designed parameters to ensure individual anonymity while hypothesizing and designing actual equations.

Imitating the Self-Immune System for Enhanced Informational Health:

To devise a network theory for enhancing informational health by mimicking the self-immune system, it is necessary to further extend supervised learning models by incorporating elements of randomization and resilience building. Below, we present hypotheses for conceptual models and equations.

1. **Randomization of Information Exposure**: - By introducing random elements into the information set users are exposed to, users have the opportunity to encounter diverse information. This helps users build resilience to various sources of information, similar to how the immune system deals with diverse pathogens.

2. **Introduction of Resilience Scores**: - Based on the reactions users exhibit toward various information, assign a resilience score to each user. This score serves as an indicator of how much informational stress a user can endure.

Hypotheses for Equations

1. **Randomization Function**: - Let $R(x)$ be the randomization function, where x is the input information, and $R(x)$ represents the randomized information set.

2. **Resilience Function**: - Let $L(y,u)$ be the resilience score function, where y is the label of the information (self/non-self), and u is the user's reaction. This function updates the user's resilience score.

3. **Training the Learning Model**: - Let $f : X \times U \to Y$, where X represents the features of the information, U represents the user's resilience score, and Y represents the label. This function assigns labels based on resilience levels.

Balancing randomization and resilience scores is crucial. Excessive randomization may lead to erratic results. This theory provides a new hypothesis for enhancing informational health by increasing the diversity of information and user resilience.

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5. Integration of Heaviside Function and Holonomic Analytic Functions

By introducing the Heaviside function and holonomic analytic functions and integrating them into the formula model based on psychological requirements, the analytical capabilities and predictive accuracy of the model are significantly improved, making it possible to estimate trends using Fisher-Bingham and Bingham distribution. The computational process is detailed below.

5.0.1 Integration Process into the Model

1. **Application of Heaviside Function**: - Apply the Heaviside function to each user's resilience score and information exposure level, binaryizing the states (active/inactive) based on specific thresholds. - This determines whether users have reached significant psychological stress levels and triggers appropriate responses.

2. **Application of Holonomic Analytic Functions**: - Use holonomic analytic functions to represent the dynamics of the network, including temporal variations. - This function helps in tracking changes in the flow of information and patterns of attacks within the network.

3. **Integration of Fisher-Bingham and Bingham Distributions**: - Apply Fisher-Bingham or Bingham distributions to network data to analyze the direction and tendencies of user behavior and attack patterns. - These distributions allow for a more detailed understanding of complex social interactions and attack trends.

5.1 Computational Process

1. **Data Preprocessing**: - Apply the Heaviside function to binaryize user information exposure $E(u)$ and attack risk $A(x,u)$. - Example: $H(E(u))$ and $H(A(x,u))$, where H is the Heaviside function.

2. **Modeling Network Dynamics**: - Use holonomic analytic functions to model network dynamics, including temporal variations. - This enables continuous tracking of various changes within the network.

3. **Trend Analysis**: - Analyze trends in binaryized data using Fisher-Bingham or Bingham distributions. - This provides a more accurate understanding of attack patterns and the direction of information flow.

4. **Prediction and Evaluation**: - Predict future attack patterns and information flow trends based on the obtained trends. - Compare prediction results with actual data or simulation results to evaluate the model's accuracy.

Stringent measures for ensuring security are necessary. - The model's results must be evaluated and applied from an ethical perspective.

This integration is expected to significantly enhance the predictive accuracy and analytical capabilities of the informational health network model, contributing to the development of more effective information health strategies.

6. Simulating an Informational Health Model Based on Psychological Requirements

Let's consider a mathematical model for simulating an informational health model based on psychological requirements.

1. Exposure of Personal Information (E) and Attack Risk (A)

$E(u)$ and $A(x,u)$ represent the exposure of personal information for user u and the level of attack risk for information x, respectively. These are randomly generated, and are represented as $E(u) = \text{rand}(0,1)$ and $A(x,u) = \text{rand}(0,1)$.

2.Application of the Heaviside Function

The Heaviside function $H(x)$ returns 1 when it exceeds a specific threshold θ and 0 otherwise. The formula is $H(x) = \begin{cases} 0 & \text{if } x < \theta \\ 1 & \text{if } x \geq \theta \end{cases}$. It is applied to $E(u)$ and $A(x,u)$ to generate binary data H_E and H_A.

3. Sampling from the Fisher-Bingham Distribution

Data following the Fisher-Bingham distribution is used for analyzing angle data.

In this simulation, a special case of the Fisher-Bingham distribution, the von Mises distribution (with concentration κ), is used. The formula for sample generation is von_mises$(\mu = 0, \kappa = 1)$.

Based on these formulas, the program randomly generates user information exposure and attack risk, binaryizes them for analysis, and generates samples from the Fisher-Bingham distribution for visualization to understand trends and patterns within the social network. This provides insights into informational health and allows for more detailed analysis and predictions.

7. Hypothesis of Consider Conflicts with the Pathological Network, Patterns

1.Perception of Victim's Weakened Immunity $V(v)$

- Function $V(v)$ representing to what extent an offender perceives the victim's weakened immunity (informational vulnerability). - Formula: $V(v) = \sum_{i=1}^{q} v_i$, where v_i are indicators of the victim's personal information exposure and other vulnerabilities.

2. Assessment of Attack Potential$O(a,v)$

- Function $O(a,v)$ evaluating the degree of potential attacks by an offender a on victim v. - This degree is calculated based on the offender's intent, means of attack, proximity to the victim, and other factors. - Formula: $O(a,v) = \eta \cdot \text{AttackPotential}(a) + \zeta \cdot \text{Proximity}(v)$, where η, ζ are adjustable coefficients.

3. Recognition of Concurrent Conditions$C(a,v)$

- Function $C(a,v)$ evaluating an offender's recognition of the victim's state when conditions (1) and (2) coexist. - Formula: $C(a,v) = \lambda \cdot V(v) + \mu \cdot O(a,v)$, where λ, μ are adjustable coefficients.

Additionally, we propose hypotheses in the computation process to consider conflicts with the pathological network, patterns leading to the destruction of an offender's self-immune network, logical contradictions and breakdowns resulting from offenders impersonating victims, and patterns of offenders reflecting on their actions.

1. Evaluation of Conflict with Pathological Network** $C(a)$

- Function $C(a)$ evaluating the degree to which an offender a conflicts with their own pathological network. - Formula: $C(a) = \sum_{i=1}^{s} c_i$, where c_i are indicators of conflict (e.g., self-contradictions, lack of behavioral consistency).

2. Destruction of Offender's Self-Immune Network** $S(a)$

- Function $S(a)$ evaluating patterns where an offender's actions lead to the destruction of their self-immune network. - Formula: $S(a) = \sum_{j=1}^{t} s_j$, where s_j are actions or psychological states related to self-destruction.

3. Impersonation and Logical Contradictions by Offender** $M(a)$

- Function $M(a)$ evaluating logical contradictions in an offender a's impersonation of victims. - Formula: $M(a) = \sum_{k=1}^{u} m_k$, where m_k are indicators of impersonation and their contradictions.

4. Evaluation of Offender's Reflection $R(a)$

- Function $R(a)$ evaluating patterns where an offender a reflects on their actions. - Formula: $R(a) = \sum_{l=1}^{v} r_l$, where r_l are actions or psychological changes related to reflection.

These hypotheses in the computation process provide a framework for quantitatively analyzing an offender's inner conflicts, self-contradictions, and the process of reflection. Through validation using real data, we can gain insights into changes in offender behavior and psychological changes, and evaluate the effectiveness of interventions and support. It is important to emphasize ethical considerations and the protection of victims' privacy when using this model.

7.1 Discussion from Hypothesis of Consider Conflicts with the Pathological Network, Patterns

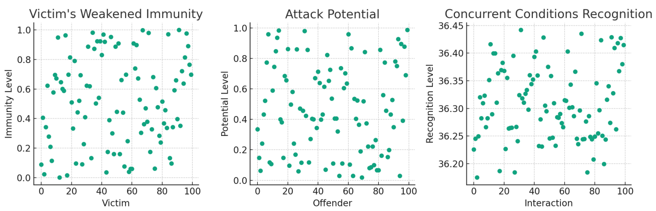

Fig. 7: Concurrent Condition Evaluation

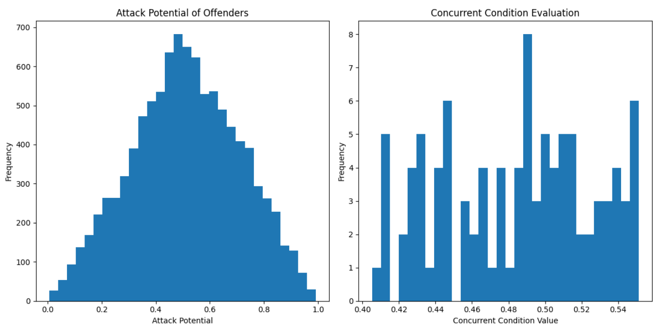

Fig. 8: Concurrent Condition Evaluation

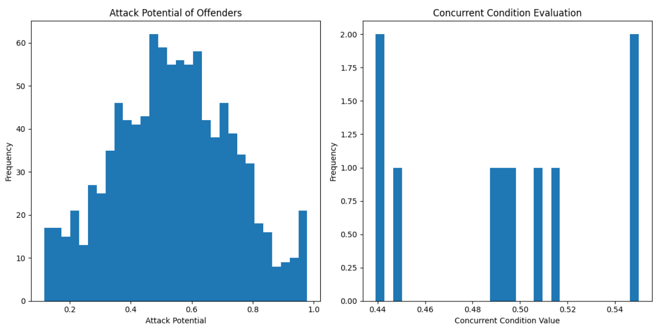

Fig. 9: Concurrent Condition Evaluation

1. Victim's Weakened Immunity

- The first scatter plot might represent the "Victim's Weakened Immunity" where each point corresponds to a victim's immunity level, as per the parameter $E(u)$, which could reflect the level of exposure or vulnerability to attacks or information risks.

2. Attack Potential

- The second scatter plot likely shows the "Attack Potential" of offenders against victims. Each point could represent the potential level of attack by an offender, as per the parameter $A(x, u)$, indicating the risk of attack given the offender's proximity and intent.

3. Concurrent Conditions Recognition

- The third scatter plot might depict "Concurrent Conditions Recognition," possibly combining the effects of exposure and attack potential to reflect how these concurrent conditions are recognized in the model, aligning with the parameter $C(a, v)$, which considers the combination of a victim's information exposure and the attack potential from offenders.

The histograms seem to provide the frequency distribution of the computed levels for "Attack Potential of Offenders" and "Concurrent Condition Evaluation". These histograms might be illustrating the overall distribution of these parameters across all simulated offenders and interactions, giving insights into the commonality of certain levels of attack potential and recognition of concurrent conditions within the simulated environment.

In discussing the findings, one would typically look at the distribution of points or frequency bars to understand the range, mean, variance, and any patterns or outliers in the data. For example, if most of the points in the "Victim's Weakened Immunity" scatter plot are high, it might suggest that a large number of victims are highly vulnerable. Similarly, if the "Attack Potential" histogram shows a significant peak, it might indicate a common level of attack potential among many offenders.

But Without the ability to directly access the data, these interpretations are speculative based on the described parameters and the common uses of scatter plots and histograms in data analysis. To draw concrete conclusions, one would need to analyze the actual numerical data and perform statistical tests as appropriate.

8. Conclusion

8.1 Simulation of Interaction Between Offenders and Victims

1. Generation of Offender and Victim Data

- Generate the immunity and attack power for both offenders and victims using random values based on the number of offenders and victims.

2. Evaluation of Offender's Attack Potential (O)

- Calculate the attack potential of offenders based on their attack power and proximity to victims. The formula is $O(a, v) = \eta \cdot \text{AttackPotential}(a) + \zeta \cdot \text{Proximity}(v)$.

3. Perception of Offenders Towards Victims (V)

- Calculate the average immunity of victims $V(v)$.

4. Assessment of Concurrent Conditions (C)

- Calculate concurrent conditions $C(a, v)$ by combining the perception of offenders towards victims and the assessment of attack potential. The formula is $C(a, v) = \lambda \cdot V(v) + \mu \cdot O(a, v)$.
- Visualize the attack potential of offenders and the assessment of concurrent conditions using histograms.

This simulation serves as a useful tool for numerically understanding the interaction between offenders and victims. Furthermore, refining the model based on real data can enhance its accuracy.

Modeling and Analyzing the Interaction Between Offenders and Victims

This program is designed to model and analyze the interaction between offenders and victims. Below, we explain the key equations included in the program and their meanings.

1. Victim Vulnerability $V(v)$

- This function indicates the degree of vulnerability of victims. - Formula: $V(v) = \sum_{i=1}^{n} v_i$, where v_i represents the vulnerability of each victim, randomly generated.

2. Attack Potential $O(a, v)$

- This function calculates the potential for attacks by offenders. - Formula: $O(a, v) = \eta \cdot a + \zeta \cdot v$, where a represents the offender's intent, v represents proximity to the victim, and η and ζ are adjustable coefficients.

3. Recognition of Concurrent Conditions $C(a, v)$

- This function indicates how offenders recognize the co-occurrence of victim vulnerability and attack potential. - Formula: $C(a, v) = \lambda \cdot V(v) + \mu \cdot O(a, v)$, where λ and μ are adjustable coefficients.

In the program, these functions are used to compute the states of offenders and victims, and the results are visualized using scatter plots and heatmaps. Specifically, victim vulnerability, offender attack potential, and their co-occurrence are represented in separate graphs.

This model provides a framework for understanding the dynamics of social interactions and analyzing attack behaviors and victim states. It has the potential to provide insights useful for predicting attack behaviors and developing defense strategies.

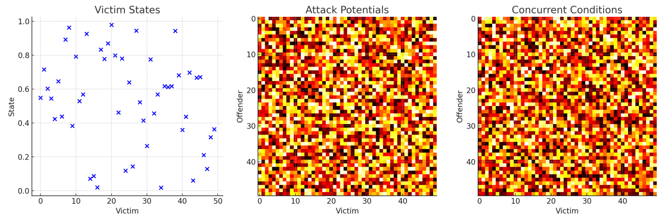

Fig. 10: Opinion Concurrent Conditions

Model Results: Quantitative Assessment of Offender-Victim Interaction

This section presents the results of the model designed to quantitatively assess the interaction between offenders and victims.

1. Victim States

- The left scatter plot displays the victim indices on the horizontal axis and victim states (degree of vulnerability) on the vertical axis. - Based on the formula $V(v) = \sum_{i=1}^{q} v_i$, each point represents randomly generated values of victim vulnerability, and the vertical axis represents their summation.

2. Attack Potentials

- The central heatmap represents attack potentials for each offender (vertical axis) against victims (horizontal axis) using varying shades of color. - The formula $O(a, v) = \eta \cdot a + \zeta \cdot v$ combines offender intent and proximity to victims, with darker colors indicating higher attack potentials.

3. Concurrent Conditions

- The right heatmap illustrates the concurrent conditions recognized by offenders regarding victims. - Based on the formula $C(a, v) = \lambda \cdot V(v) + \mu \cdot O(a, v)$, areas with darker colors appear when both offender and victim vulnerabilities and attack potentials are high.

From these results, it is possible to visually understand how the offensive behaviors of offenders and the vulnerabilities of victims interact within the model. Victim states may exhibit relatively uniform distribution, while attack potentials and concurrent conditions are expected to demonstrate more complex patterns. These patterns may suggest specific characteristics of interactions between offenders and victims, and these insights can be valuable for developing defense strategies and adjusting intervention measures.

For the Victim States graph

- This scatter plot likely shows the individual vulnerability levels (immunity levels) of each victim. Higher points indicate greater exposure or weakened immunity. A clustering of

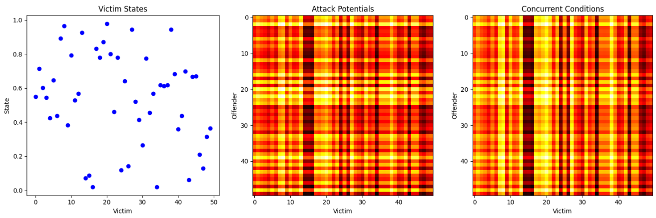

Fig. 11: Opinion Concurrent Conditions

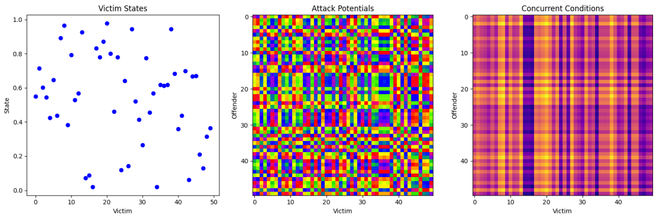

Fig. 12: Opinion Concurrent Conditions

points towards the top of the graph could suggest a group of victims with high exposure levels.

For the Attack Potentials heatmap

This could represent the potential for each offender (on the y-axis) to attack each victim (on the x-axis). Brighter colors could indicate higher potential for attack, which could be the result of higher offender intent and/or closer proximity to the victim.

For the Concurrent Conditions heatmap

- This would depict the combined condition of personal information exposure and risk from attacks or external information. - Similar to the Attack Potentials heatmap, brighter colors might indicate higher levels of concurrent risk factors.

Future Works

If for the histograms, if they relate to the Heaviside function output or the Fisher-Bingham distribution: The histograms would show the distribution of the binary outputs (0 or 1) from applying the Heaviside function to a dataset, likely related to a threshold of vulnerability or attack potential. A Fisher-Bingham distribution histogram would depict the frequency of data points that fall within certain ranges, which could be used to analyze the orientation or directional data in the context of social network interactions.

When looking at these types of visualizations, consider how the spread and concentration of data points relate to the underlying phenomena you're studying, such as how well the victims are protected against information exposure or how aggressive the potential attacks are. Patterns in the data might suggest areas of risk or opportunities for intervention.

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