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4. TITLE AND SUBTITLE Final Report: Evaluating and Advancing Deviant Cyber Flash Mob (DCFM) Model to Combat COVID-19 Misinfodemic	5a. CONTRACT NUMBER W911NF-20-1-0262
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7. PERFORMING ORGANIZATION NAMES AND ADDRESSES University of Arkansas @ Little Rock 2801 South University Avenue Little Rock, AR 72204 -1000	8. PERFORMING ORGANIZATION REPORT NUMBER
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13. SUPPLEMENTARY NOTES The views, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy or decision, unless so designated by other documentation.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	15. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON Nitin Agarwal
a. REPORT UU	b. ABSTRACT UU	c. THIS PAGE UU			19b. TELEPHONE NUMBER 501-916-5224

RPPR Final Report

as of 22-May-2023

Agency Code: 21XD

Proposal Number: 77196HC

Agreement Number: W911NF-20-1-0262

INVESTIGATOR(S):

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DUNS Number: 036725083

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Report Date: 31-Mar-2022

Date Received: 19-May-2023

Final Report for Period Beginning 01-Jul-2020 and Ending 31-Dec-2021

Title: Evaluating and Advancing Deviant Cyber Flash Mob (DCFM) Model to Combat COVID-19 Misinfodemic

Begin Performance Period: 01-Jul-2020

End Performance Period: 31-Dec-2021

Report Term: 0-Other

Submitted By: Nitin Agarwal

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Distribution Statement: 1-Approved for public release; distribution is unlimited.

STEM Degrees:

STEM Participants:

Major Goals: The major research goal of the study is to study COVID-19-related cross-media misinformation campaigns and evaluate the deviant cyber flash mob (DCFM) model to measure and track the power of such campaigns. The study focuses on analyzing how decentralized online individual actions transform into collective actions. Further, what necessary conditions are required that lead to the emergence of the DCFM phenomenon and, subsequently, its sustenance? Specifically, the proposed study (1) extends focal structure analysis to identify key coordinating units spreading COVID-19-related misinformation; and (2) measures the power of focal structures using the DCFM model.

Accomplishments: The grant led to several accomplishments, as listed below:

- DCFM model was operationalized in online COVID-19 discourse communities that espoused misinformation in a multi-social media platform setting, including Twitter, Reddit, Parler, YouTube, and blogs.
- implemented a systematic agent-based method to respond to the COVID-19 misinformation spread on social networks.
- created a database and website to enable the continual collection, analysis, and communication of COVID-19 misinformation narratives, scams, and hoaxes that are disseminated across various social media platforms such as Twitter, Facebook, YouTube, WhatsApp, Instagram, TikTok, websites, and numerous others (<https://cosmos.ualr.edu/covid-19>).
- identified trends in COVID-19 misinformation themes
- analyzed toxicity and its contagion in online COVID-19 discourse communities that espoused misinformation.
- worked with Arkansas Attorney General's office to implement the COVID-19 misinformation tracker at state level to educate people about misinformation threats and combat scams.
- the effort was recognized by WHO and NATO as technological innovation to combat cognitive warfare.

Details on the above approaches are included in the publications uploaded in the system. Summaries are provided below:

- Implementing systems thinking methods to help the decision-maker to monitor easily, react to any misinformation spread in an online network, and build the best response strategies to respond in the offline environment. In this research, we used a Twitter network related to the armed protest demonstration against COVID-19 lockdown at Michigan state on May 12th through May 15th, 2020. In addition, to implement our methodology and to analyze the behavior of the state/non-state users and extremist groups used social networks to spread information, we used different systems thinking methods to simplify the analysis as follows: -Organizational Cybernetics: It is the study of control and communication between any systems and environment that includes different positive and negative feedback, variety of behavior from all parts in a system, and increased complexity. -Concept mapping: it is a

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systems method that enables groups to describe their ideas on any topic, present their ideas visually, and use statistical analysis and multidimensional scaling to cluster the concepts. -One-Median Problem: It is a location problem used to enhance the agent's performance to respond to incidents on the network. This method was implemented to study the stochastic incidents in dynamic networks where the users and communities evolve over time. In addition, the agent would use this method to allocate and prioritize the sources of the spread, optimize the operation level/ agent's response time, and implement the best response strategies to the unpredicted behavior of users/communities in real-time. Useful tools applied to merge different disciplines into social networks analysis. The systematic analysis revealed two campaigns implemented noncooperative actions spreading information on the Twitter network. In response to these behaviors, our model was able to build a strategy to find the patterns of users on the network, and based on their position, the model was able to optimize the agents' response time to any spread across the network. Furthermore, we prioritize the communities and provided the best strategies to enhance the performance of the agent to limit the spread of misinformation across the network in real-time. In addition, the model was able to easily illustrate the information flow between communities and the interaction between the agents and the online and offline environments over time.

- Misinformation Topic Themes We created a database and website to enable the continual collection, analysis, and communication of COVID-19 misinformation narratives, scams, and hoaxes that disseminated across various social media platforms such as Twitter, Facebook, YouTube, WhatsApp, Instagram, TikTok, websites, and numerous others (<https://cosmos.ualr.edu/covid-19>). Although assessable worldwide, this work was created at the request of the Office of the Arkansas Attorney General to help combat COVID-19 misinformation within the state. We have published several studies based on this COVID-19 misinformation data wherein the objectives included the identification of the dominant topic themes of the misinformation and the evolution of those themes over time. The data collection methodology consisted of a manual aggregation of misinformation items that have multiple public disproof sources. The dataset is comprised of 543 misinformation items (243 unique). For many of the items, multiple platforms were used to spread the misinformation. For example, oftentimes a misinformation item is simultaneously posted on Facebook, Twitter, YouTube, and as an article on a website. Within this dataset, the top platforms used for spreading COVID-19 misinformation were websites, Facebook, Twitter, YouTube, and Instagram, respectively. Using the Latent Dirichlet Allocation model (LDA), dominant themes stood out, changing over time. In March, the prominent misinformation theme was the promotion of remedies to supposedly prevent, treat, or kill the novel coronavirus. In April, several misinformation items attempted to downplay the deadliness of the virus, while others discussed the anti-malaria drug hydroxychloroquine, the idea that the virus was a hoax meant to defeat President Donald Trump, and the idea that 5G caused the virus. In May, we started to see attempts to convince citizens that face masks were either more harmful than not wearing one, or were ineffective at preventing COVID-19, and how to avoid rules that required their use. The number and variety of identity theft phishing scams also increased during May. Also becoming prominent in May were misinformation items attempting to spread fear about a potential COVID-19 vaccine, and items actively promoting the use of hydroxychloroquine. During the month of June, the prominent theme shifted significantly to increased attempts to convince citizens that face masks were either more harmful than not wearing one, and how to avoid rules that required their use. Phishing scams also remained prominent during June. During the month of July, the dominant themes of the misinformation items shifted back to attempts to downplay the deadliness of the novel coronavirus. Another prominent theme in July was an attempt to convince the public that COVID-19 testing was inflating the results. The identification of these dominant topic themes allowed the AR Attorney General's Office to tailor outreach communications in their efforts to educate the public and stem the spread of the misinformation and prevent additional victims of scams. Due to the identification of its prevalence of use as a misinformation dissemination tool, additional data was collected in the form of 652,120 comments from 444 COVID-19-related YouTube videos for the month of March 2020 to identify early dominant misinformation items [6]. In this dataset, dominant topics centered around "trump", "plandemic", "china", and "bats". LDA and hierarchical Dirichlet process (HDP) were compared to see which performed best at identifying the topics. HDP stood out in its ability to isolate a probable subset of polarizing comments, which will be explored further in future work.

- Toxicity Analysis: We conducted toxicity analysis of a large dataset of user comments posted on COVID-19-related YouTube videos between January 1 through April 30, 2020. The objectives of this work included the analysis of the evolution of toxicity within an online social network (OSN) for a specific timeframe, the identification of the dominant topics that were being discussed, the identification of key nodes within the network that served to propagate the toxicity, and the simulation of how the strategic removal of influential nodes can improve network health.

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Training Opportunities: PI and students working on the project presented the results at several international conferences and journals. Participation at these conferences provided training opportunities to the PI and the students.

Results Dissemination: - Results of the study have been disseminated widely through 45 conference presentations, 18 proceedings publications, 5 book chapters, 9 journal articles, 2 tutorial presentations, 2 summer school talks, 2 keynote addresses, and 2 panel talks.

- All the published papers have been uploaded to the reporting system.

- Database for COVID-19 misinformation was made available on COVID-19 misinformation tracker website that has helped the Arkansas Office of the Attorney General combat COVID-19 misinformation.

Honors and Awards: - Best Paper Award for our paper on Studying the Dynamics of COVID-19 Misinformation Themes using Topic Streams. In proceedings of The Seventh International Conference on Human and Social Analytics (HUSO 2021), July 18-22, 2021. Nice, France.

- Won disinformation challenge for our paper titled, "Optimizing Response Time to Minimize Spreading of Conspiracy Theories in Dynamic Social Networks" at the 2021 International Conference on Social Computing, Behavioral-Cultural Modeling & Prediction, and Behavior Representation in Modeling and Simulation (SBP-BRIMS 2021), July 6-9, 2021, Washington D.C.

- Best Paper Award for our paper on YouTube Video Categorization Using Moviebarcode. In proceedings of the Sixth International Conference on Human and Social Analytics (HUSO 2020), October 18-22, 2020, Porto, Portugal.

- PI was the Recipient of 2021 UALR Faculty Excellence Award for Research and Creative Endeavors. April 15, 2021.

- Best Paper Award for our paper on Developing Situational Awareness from Blogosphere: An Australian Case Study. In Proceedings of the Eleventh International Conference on Social Media Technologies, Communication, and Informatics (SOTICS 2021), October 3-7, 2021, Barcelona, Spain.

- Recognized as one of the top 10 teams by NATO from 132 teams across 30 member nations that offer solutions to the challenge titled "The Invisible Threat: Countering Cognitive Warfare" organized by NATO's Innovation Hub. November 30, 2021.

- Our COVID-19 Misinformation tracker was recognized by the World Health Organization (WHO) as one of the key technological innovations developed across the world to address the COVID-19 pandemic in February 21, 2022. The work conducted during the grant was recognized after the grant expired.

Protocol Activity Status:

Technology Transfer:

Developed COVID-19 Misinformation Tracker system and made it publicly accessible at <https://cosmos.ualr.edu/covid-19>. The system has been widely used within the state of Arkansas and by the Office of the Attorney General of Arkansas to combat COVID-19 misinformation.

PARTICIPANTS:

Participant Type: PD/PI

Participant: Nitin Agarwal

Person Months Worked: 1.00

Project Contribution:

National Academy Member: N

Funding Support:

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Publication Type: Journal Article Peer Reviewed: Y **Publication Status:** 1-Published

Journal: Information Processing & Management

Publication Identifier Type: DOI

Publication Identifier: 10.1016/j.ipm.2020.102385

Volume: 58

Issue: 1

First Page #: 102385

Date Submitted: 8/24/21 12:00AM

Date Published: 1/1/21 12:00PM

Publication Location:

Article Title: Combining advanced computational social science and graph theoretic techniques to reveal adversarial information operations

Authors: Mustafa Alassad, Billy Spann, Nitin Agarwal

Keywords: Focal structure analysis, Deviant cyber flash mob detection, Centrality-modularity, Misinformation, Disinformation, Hub and spoke, Adversarial behaviors, Information operations, Social networks

Abstract: Social media has influenced socio-political aspects of many societies around the world. It is an effortless way for people to enhance their communication, connect with like-minded people, and share ideas. Online social networks (OSNs) can be used for noble causes by bringing together communities with common shared interests and to promote awareness of various causes. However, there is a dark side to the use of OSNs. OSNs can also be used as a coordination and amplification platform for attacks. For instance, adversaries can increase the impact of an attack by causing panic in an area by promoting attacks using OSNs. Public data can help adversaries to determine the best timing for attacks, scheduling attacks, and then using OSNs to coordinate attacks on networks or physical locations. This convergence of the cyber and physical worlds is known as cybernetics. In this paper, we introduce an integrated method to identify malicious behavior and the actors responsible for propagating this b

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Publication Type: Journal Article Peer Reviewed: Y **Publication Status:** 1-Published

Journal: Information Processing & Management

Publication Identifier Type: DOI

Publication Identifier: 10.1016/j.ipm.2021.102660

Volume: 58

Issue: 5

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Date Submitted: 8/26/21 12:00AM

Date Published: 9/1/21 5:00AM

Publication Location:

Article Title: Developing a socio-computational approach to examine toxicity propagation and regulation in COVID-19 discourse on YouTube

Authors: Adewale Obadimu, Tuja Khaund, Esther Mead, Thomas Marcoux, Nitin Agarwal

Keywords: Toxicity analysis, Social network analysis, Topic modeling, Pandemic, COVID-19, YouTube, Social media

Abstract: As the novel coronavirus (COVID-19) continues to ravage the world at an unprecedented rate, formal recommendations from medical experts are becoming muffled by the avalanche of toxic content posted on social media platforms. This high level of toxic content prevents the dissemination of important and time-sensitive information and jeopardizes the sense of community that online social networks (OSNs) seek to cultivate. In this article, we present techniques to analyze toxic content and actors that propagated it on YouTube during the initial months after COVID-19 information was made public. Our dataset consists of 544 channels, 3,488 videos, 453,111 commenters, and 849,689 comments. We applied topic modeling based on Latent Dirichlet Allocation (LDA) to identify dominant topics and evolving trends within the comments on relevant videos. We conducted social network analysis (SNA) to detect influential commenters, and toxicity analysis to measure the health of the network. SNA allows us t

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Publication Type: Journal Article Peer Reviewed: Y **Publication Status:** 4-Under Review
Journal: Journal of Social Network Analysis and Mining (SNAM)
Publication Identifier Type: Publication Identifier:
Volume: Issue: First Page #:
Date Submitted: 8/27/21 12:00AM Date Published:
Publication Location:

Article Title: Flash Mobs: A Multidisciplinary Review

Authors: Samer Al-Khaeteeb, Nitin Agarwal

Keywords: Mob, Flash Mob, Smart Mob, Deviant Cyber Flash Mob, Rob Mob, Social Media

Abstract: Since the year 2003, the term “flash mob” has been studied in various disciplines and was referred to by various media outlets to describe various events. The term “flash mob” originally meant to describe a phenomenon in which a group of people assembles in a public space, perform a seemingly random act, then quickly disperse. This phenomenon was expected to die just like other types of public performances, e.g., the eighties’ raves. However, this phenomenon is still alive and became widespread in various forms. Since this phenomenon was new, mentioned in the media, and depended on technology, it’s unwise to assume that everyone knows its exact meaning. Many traditionalist flash mobbers become concerned that the global diffusion of flash mobs has diluted their original meaning. So, in this summative, chronological, and by topic literature review article, we explore the disciplines in which this term was used; then investigate its various forms and propose the term “Mob” to be the ...

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Acknowledged Federal Support: Y

Publication Type: Journal Article Peer Reviewed: Y **Publication Status:** 1-Published
Journal: Transactions on Computational Social Systems (TCSS)
Publication Identifier Type: DOI Publication Identifier: 10.1109/TCSS.2021.3103515
Volume: Issue: First Page #:
Date Submitted: 8/27/21 12:00AM Date Published: 8/19/21 5:47PM
Publication Location:

Article Title: Social Bots and Their Coordination during Online Campaigns: A Survey

Authors: Tuja Khaund, Baris Kirdemir, Nitin Agarwal, Fred Morstatter, Huan Liu

Keywords: Bot detection, coordination, online social networks (OSNs), social bots, social media, social network analysis (SNA)

Abstract: Online social networks (OSNs) are a major component of societal digitalization. OSNs alter how people communicate, make decisions, and form or change their beliefs, attitudes, and behaviors. Thus, they can now impact social groups, financial systems, and political communication at scale. As one type of OSN, social media platforms, such as Facebook, Twitter, and YouTube, serve as outlets for users to convey information to an audience as broad or targeted as the user desires. Over the years, these social media platforms have been infected with automated accounts, or bots, that are capable of hijacking conversations, influencing other users, and manipulating content dissemination. Although benign bots exist to facilitate legitimate activities, we focus on bots designed to perform malicious acts through social media platforms. Bots that mimic the social behaviors of humans are referred to as social bots. Social bots help automate sociotechnical behaviors, such as “liking” tweets,

...

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CONFERENCE PAPERS:

RPPR Final Report as of 22-May-2023

Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: 29th International Joint Conference on Artificial Intelligence and the 17th Pacific Rim International Conference on Artificial Intelligence (IJCAI-PRICAI 2020)
Date Received: 27-Aug-2021 Conference Date: 11-Jul-2020 Date Published:
Conference Location: Virtual due to COVID-19
Paper Title: Inductive Anomaly Detection on Attributed Networks
Authors: Kaize Ding, Nitin Agarwal, and Huan Liu
Acknowledged Federal Support: **Y**

Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: 11th International Conference on Social Media & Society (SMSociety 2020)
Date Received: 27-Aug-2021 Conference Date: 22-Jul-2020 Date Published:
Conference Location: Virtual due to COVID-19
Paper Title: Comparative Discourse Analysis using Topic Models: Contrasting Perspectives on China from Reddit
Authors: Zachary Stine, Nitin Agarwal
Acknowledged Federal Support: **Y**

Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: 7th International Conference on Information Management and Big Data (SIMBig 2020)
Date Received: 27-Aug-2021 Conference Date: 01-Oct-2020 Date Published:
Conference Location: Virtual due to COVID-19
Paper Title: Telegram: Data Collection, Opportunities and Challenges
Authors: Tuja Khaund, Muhammad Nihal Hussain, Mainuddin Shaik, Nitin Agarwal
Acknowledged Federal Support: **Y**

Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: 2020 International Conference on Social Computing, Behavioral-Cultural Modeling & Prediction, and Behavior Representation in Modeling and Simulation (SBP-BRiMS 2020)
Date Received: 27-Aug-2021 Conference Date: 18-Oct-2020 Date Published:
Conference Location: Virtual due to COVID-19
Paper Title: Developing an Epidemiological Model to study Spread of Toxicity on YouTube
Authors: Adewale Obadimu, Esther Mead, Maryam Maleki, Nitin Agarwal
Acknowledged Federal Support: **Y**

Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: 2020 International Conference on Social Computing, Behavioral-Cultural Modeling & Prediction, and Behavior Representation in Modeling and Simulation (SBP-BRiMS 2020)
Date Received: 27-Aug-2021 Conference Date: 18-Oct-2020 Date Published:
Conference Location: Virtual due to COVID-19
Paper Title: Developing Graph-Theoretic Techniques to Identify Amplification and Coordination Activities of Influential Sets of Users
Authors: Mustafa Alassad, Muhammad Nihal Hussain, Nitin Agarwal
Acknowledged Federal Support: **Y**

Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: 2020 International Conference on Social Computing, Behavioral-Cultural Modeling & Prediction, and Behavior Representation in Modeling and Simulation (SBP-BRiMS 2020)
Date Received: 27-Aug-2021 Conference Date: 18-Oct-2020 Date Published:
Conference Location: Virtual due to COVID-19
Paper Title: Artifacts of Crisis: Textual Analysis of Euromaidan
Authors: Thomas Magelinski, Zachary Stine, Thomas Marcoux, Nitin Agarwal, Kathleen Carley
Acknowledged Federal Support: **Y**

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Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: The Sixth International Conference on Human and Social Analytics (HUSO 2020)
Date Received: 27-Aug-2021 Conference Date: 18-Oct-2020 Date Published:
Conference Location: Virtual due to COVID-19
Paper Title: YouTube Video Categorization Using Moviebarcode
Authors: Recep Erol, Rick Rejeleene, Richard Young, Thomas Marcoux, Muhammad Nihal Hussain, Nitin Agarwal
Acknowledged Federal Support: **Y**

Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: 5th International Workshop on Mining Actionable Insights from Social Networks Special Edition on Dis/Misinformation Mining from Social Media (MAISON 2020)
Date Received: 27-Aug-2021 Conference Date: 20-Oct-2020 Date Published:
Conference Location: Virtual due to COVID-19
Paper Title: The Ebb and Flow of the COVID-19 Misinformation Themes
Authors: Thomas Marcoux, Esther Mead, Nitin Agarwal
Acknowledged Federal Support: **Y**

Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: International Conference on Social-cybersecurity in Times of Crisis and Change
Date Received: 27-Aug-2021 Conference Date: 19-Nov-2020 Date Published:
Conference Location: Virtual due to COVID-19
Paper Title: Modeling Protester Orchestration through Connective Action: A COVID-19 Lockdown Protest Case Study
Authors: Billy Spann, Oluwaseun Johnson, Esther Mead, Nitin Agarwal
Acknowledged Federal Support: **Y**

Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: International Conference on Social-cybersecurity in Times of Crisis and Change
Date Received: 27-Aug-2021 Conference Date: 19-Nov-2020 Date Published:
Conference Location: Virtual due to COVID-19
Paper Title: Studying the Dynamics of COVID-19 Misinformation Themes
Authors: Thomas Marcoux, Esther Mead, Nitin Agarwal
Acknowledged Federal Support: **Y**

Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: International Conference on Social-cybersecurity in Times of Crisis and Change
Date Received: 27-Aug-2021 Conference Date: 19-Nov-2020 Date Published:
Conference Location: Virtual due to COVID-19
Paper Title: Systems Thinking and Modeling in Social Networks: A Case Study of Controlling COVID-19 Conspiracy Theories
Authors: Mustafa Al Assad, Muhammad Nihal Hussain, Nitin Agarwal
Acknowledged Federal Support: **Y**

Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: International Conference on Social-cybersecurity in Times of Crisis and Change
Date Received: 27-Aug-2021 Conference Date: 19-Nov-2020 Date Published:
Conference Location: Virtual due to COVID-19
Paper Title: Utilizing Topic Modeling and Social Network Analysis to Identify and Regulate Toxic COVID-19 Behaviors on YouTube
Authors: Adewale Obadimu, Tuja Khaund, MaryEtta Morris, Esther Mead, Nitin Agarwal
Acknowledged Federal Support: **Y**

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Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: International Conference on Social-cybersecurity in Times of Crisis and Change
Date Received: 27-Aug-2021 Conference Date: 19-Nov-2020 Date Published:
Conference Location: Virtual due to COVID-19
Paper Title: Social Media, News, Polarization, and Disinformation In Times Of Crisis: A Case Study On Turkey
Authors: Baris Kirdemir, Nitin Agarwal
Acknowledged Federal Support: **Y**

Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: Computational Humanities Research (CHR 2020)
Date Received: 27-Aug-2021 Conference Date: 18-Nov-2020 Date Published:
Conference Location: Virtual due to COVID-19
Paper Title: Comparative religion, topic models, and conceptualization: Towards the characterization of structural relationships between online religious discourses
Authors: Zachary Stine, James Deitrick, Nitin Agarwal
Acknowledged Federal Support: **Y**

Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: Workshop on Deviant Activities on Social Media (DEVIANCE 2020) co-located with 2020 IEEE International Conference on Big Data (IEEE BigData 2020)
Date Received: 27-Aug-2021 Conference Date: 10-Dec-2020 Date Published:
Conference Location: Virtual due to COVID-19
Paper Title: How to Control Coronavirus Conspiracy Theories in Twitter? A Systems Thinking and Social Networks Modeling Approach
Authors: Mustafa Alassad, Muhammad Nihal Hussain, Nitin Agarwal
Acknowledged Federal Support: **Y**

Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: 45th IEEE International Wireless World Research Forum (WWRF 45)
Date Received: 27-Aug-2021 Conference Date: 18-Jan-2021 Date Published:
Conference Location: Virtual due to COvid-19
Paper Title: Modeling, Estimating, and Minimizing Average New Infections of COVID-19 Based on Information Theory and Social Networks
Authors: Hussein Al-Hamdani, Mustafa Alassad, Nitin Agarwal, Seshadri Mohan
Acknowledged Federal Support: **Y**

Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: 23rd International Conference on Human Computer Interaction (HCI International)
Date Received: 27-Aug-2021 Conference Date: 24-Jul-2021 Date Published:
Conference Location: Virtual due to COVID-19
Paper Title: Using Information Divergence to Differentiate Deep from Superficial Resemblances among Discourses
Authors: achary Stine, James Deitrick, Nitin Agarwal
Acknowledged Federal Support: **Y**

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Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: 2nd International Workshop on Algorithmic Bias in Search and Recommendation (BIAS) co-located with 43rd European Conference on Information Retrieval
Date Received: 27-Aug-2021 Conference Date: 28-Mar-2021 Date Published:
Conference Location: Virtual due to COVID-19
Paper Title: Evaluating Video Recommendation Bias on YouTube
Authors: Baris Kirdemir, Maryetta Morris, Esther Mead, Muhammad Nihal Hussain, Nitin Agarwal
Acknowledged Federal Support: **Y**

Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: 4th International Workshop on Narrative Extraction from Texts (Text2Story) co-located with 43rd European Conference on Information Retrieval
Date Received: 27-Aug-2021 Conference Date: 28-Mar-2021 Date Published:
Conference Location: Virtual due to COVID-19
Paper Title: Narrative Trends of COVID-19 Misinformation
Authors: Thomas Marcoux, Nitin Agarwal
Acknowledged Federal Support: **Y**

Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: 4th International Workshop on Narrative Extraction from Texts (Text2Story) co-located with 43rd European Conference on Information Retrieval
Date Received: 27-Aug-2021 Conference Date: 28-Mar-2021 Date Published:
Conference Location: Virtual due to COVID-19
Paper Title: Stories from Blogs: Computational Extraction and Visualization of Narratives
Authors: Muhammad Nihal Hussain, Hayder Al Rubaye, Kiran Kumar Bandeli, Nitin Agarwal
Acknowledged Federal Support: **Y**

Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: Data Science for Social Good (DSSG) co-located with 30th ACM International The Web Conference
Date Received: 27-Aug-2021 Conference Date: 12-Apr-2021 Date Published:
Conference Location: Virtual due to COVID-19
Paper Title: Proposing a Broader Scope of Predictive Features for Modeling Refugee Counts
Authors: Esther Mead, Maryam Maleki, Recep Erol, Nitin Agarwal
Acknowledged Federal Support: **Y**

Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: International Conference on Fake News, Social Media Manipulation and Misinformation (ICFNSMMM)
Date Received: 27-Aug-2021 Conference Date: 08-Apr-2021 Date Published:
Conference Location: Virtual due to COVID-19
Paper Title: Using an Epidemiological Model to Study the Spread of Misinformation during the Black Lives Matter Movement
Authors: Maryam Maleki, Esther Mead, Mohammad Arani, Nitin Agarwal
Acknowledged Federal Support: **Y**

RPPR Final Report as of 22-May-2023

Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: 31st European Conference on Operational Research, session: Computational Intelligence in Social Sciences, stream: Modelling and Simulation of Social-Behavioural Phenomena in Creative Societies
Date Received: 27-Aug-2021 Conference Date: 11-Jul-2021 Date Published:
Conference Location: Virtual due to COVID-19
Paper Title: Applying epidemiological model to evaluate and compare the propagation of misinformation and legitimate hashtags related to COVID
Authors: Maryam Maleki, Esther Mead, Nitin Agarwal
Acknowledged Federal Support: **Y**

Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: 31st European Conference on Operational Research, session: Computational Intelligence in Social Sciences, stream: Modelling and Simulation of Social-Behavioural Phenomena in Creative Societies
Date Received: 27-Aug-2021 Conference Date: 11-Jul-2021 Date Published:
Conference Location: Virtual due to COVID-19
Paper Title: A Novel Systematic Approach to Inspect Focal Patterns in Dynamic Social Networks
Authors: Mustafa Alassad, Nitin Agarwal
Acknowledged Federal Support: **Y**

Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: 31st European Conference on Operational Research, session: Computational Intelligence in Social Sciences, stream: Modelling and Simulation of Social-Behavioural Phenomena in Creative Societies
Date Received: 27-Aug-2021 Conference Date: 11-Jul-2021 Date Published:
Conference Location: Virtual due to COVID-19
Paper Title: Towards a Multi-method Socio-Computational Approach for Analyzing Toxicity Propagation Among User-generated Discourse about COVID-19 on YouTube
Authors: Ruchi Agarwal, Karen DiCicco, Esther Mead, Nitin Agarwal
Acknowledged Federal Support: **Y**

Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: 2021 International Conference on Social Computing, Behavioral-Cultural Modeling & Prediction, and Behavior Representation in Modeling and Simulation (SBP-BRiMS 2021)
Date Received: 27-Aug-2021 Conference Date: 06-Jul-2021 Date Published:
Conference Location: Virtual due to COVID-19
Paper Title: Applying an Epidemiological Model to Evaluate the Propagation of Misinformation and Legitimate COVID-19-related Information on Twitter
Authors: Maryam Maleki, Mohammad Arani, Erik Buchholz, Esther Mead, Nitin Agarwal
Acknowledged Federal Support: **Y**

Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: 2021 International Conference on Social Computing, Behavioral-Cultural Modeling & Prediction, and Behavior Representation in Modeling and Simulation (SBP-BRiMS 2021)
Date Received: 27-Aug-2021 Conference Date: 06-Jul-2021 Date Published:
Conference Location: Virtual due to COVID-19
Paper Title: Using Diffusion of Innovations Theory to Study Connective Action Campaigns
Authors: Billy Spann, Nitin Agarwal, Esther Mead, Therese Williams
Acknowledged Federal Support: **Y**

RPPR Final Report as of 22-May-2023

Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: 2021 International Conference on Social Computing, Behavioral-Cultural Modeling & Prediction, and Behavior Representation in Modeling and Simulation (SBP-BRiMS 2021)
Date Received: 27-Aug-2021 Conference Date: 06-Jul-2021 Date Published:
Conference Location: Virtual due to COVID-19
Paper Title: Assessing Bias in YouTube's Video Recommendation Algorithm in a Cross-lingual and Cross-topical Context
Authors: Baris Kirdemir, Joseph Kready, Esther Mead, Muhammad Nihal Hussain, Nitin Agarwal, Donald Adjeroh
Acknowledged Federal Support: **Y**

Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: 2021 International Conference on Social Computing, Behavioral-Cultural Modeling & Prediction, and Behavior Representation in Modeling and Simulation (SBP-BRiMS 2021)
Date Received: 27-Aug-2021 Conference Date: 06-Jul-2021 Date Published:
Conference Location: Virtual due to COVID-19
Paper Title: Studying the Role of Social Bots During Cyber Flash Mobs
Authors: Samer Al-Khateeb, Madelyn Anderson, Nitin Agarwal
Acknowledged Federal Support: **Y**

Publication Type: Conference Paper or Presentation **Publication Status:** 1-Published
Conference Name: The Seventh International Conference on Human and Social Analytics (HUSO 2021)
Date Received: 27-Aug-2021 Conference Date: 18-Jul-2021 Date Published:
Conference Location: Virtual due to COVID-19
Paper Title: Studying the Dynamics of COVID-19 Misinformation Themes using Topic Streams
Authors: Thomas Marcoux, Esther Mead, Nitin Agarwal
Acknowledged Federal Support: **Y**

DISSERTATIONS:

Publication Type: Thesis or Dissertation
Institution: University of Arkansas at Little Rock
Date Received: 26-Aug-2021 Completion Date: 5/1/21 8:46PM
Title: OPTIMIZING DATA INGESTION AND RETRIEVAL FOR NARRATIVE ANALYSIS USING PARALLEL POOLS AND ELASTICSEARCH
Authors: Seun Johnson
Acknowledged Federal Support: **Y**

Publication Type: Thesis or Dissertation
Institution: University of Arkansas at Little Rock
Date Received: 26-Aug-2021 Completion Date: 5/1/21 5:00AM
Title: OPTIMIZING CLUSTER GENERATION AND RETRIEVAL USING NVIDIA RAPIDS LIBRARY ON HIGH PERFORMING PROCESSING UNITS
Authors: Uchenna Umoga
Acknowledged Federal Support: **Y**

Publication Type: Thesis or Dissertation
Institution: University of Arkansas at Little Rock
Date Received: 26-Aug-2021 Completion Date: 5/1/21 5:00AM
Title: LEVERAGING SOCIAL NETWORK ANALYSIS AND SUPERVISED MACHINE LEARNING TO STUDY COORDINATION IN ONLINE INFORMATION CAMPAIGNS
Authors: Tuja Khaund
Acknowledged Federal Support: **Y**

RPPR Final Report
as of 22-May-2023

Publication Type: Thesis or Dissertation

Institution: University of Arkansas at Little Rock

Date Received: 26-Aug-2021

Completion Date: 5/1/21 5:00AM

Title: COMPUTATIONAL METHODS FOR COMPARATIVE ANALYSES OF DISCOURSES

Authors: Zachary Stine

Acknowledged Federal Support: **Y**

Publication Type: Thesis or Dissertation

Institution: University of Arkansas at Little Rock

Date Received: 26-Aug-2021

Completion Date: 12/1/20 6:00AM

Title: OPTIMIZING WEB APPLICATION USING ELK STACK

Authors: Shishila Shimray

Acknowledged Federal Support: **Y**

Publication Type: Thesis or Dissertation

Institution: University of Arkansas at Little Rock

Date Received: 26-Aug-2021

Completion Date: 12/1/20 6:00AM

Title: CREATING A MACHINE LEARNING MODEL FOR THE PREDICTION OF REFUGEE FLOWS

Authors: Esther Mead

Acknowledged Federal Support: **Y**

Publication Type: Thesis or Dissertation

Institution: University of Arkansas at Little Rock

Date Received: 26-Aug-2021

Completion Date: 8/1/20 9:16PM

Title: ASSESSING THE ROLE OF SOCIAL MEDIA PLATFORMS IN THE PROPAGATION OF TOXICITY

Authors: Adewale Obadimu

Acknowledged Federal Support: **Y**

Partners

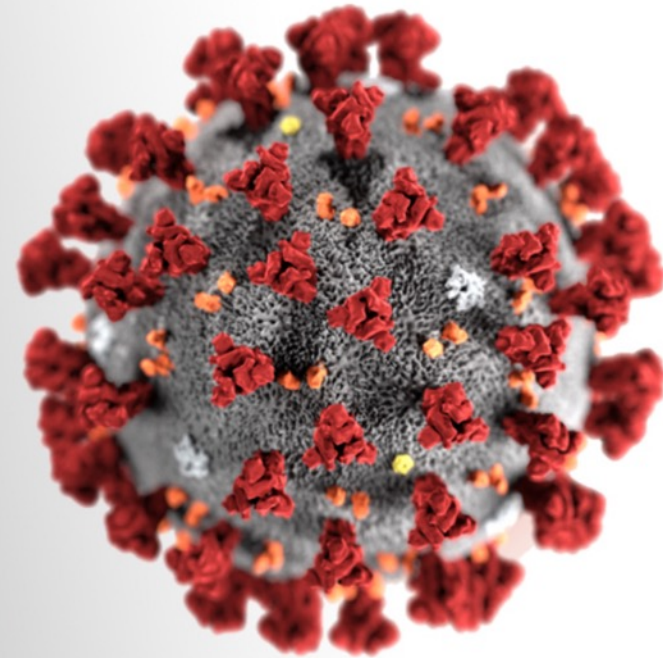
I certify that the information in the report is complete and accurate:

Signature: Nitin Agarwal

Signature Date: 5/19/23 5:36PM

COVID-19

Misinformation



FIND OUT ABOUT COVID-19 MISINFORMATION, READ TIPS ON HOW TO IDENTIFY IT AND REPORT IT.

Nitin Agarwal, Ph.D. (nxagarwal@ualr.edu)
Jerry L. Maulden-Entergy Chair and Distinguished Professor
Director, COSMOS Center
University of Arkansas – Little Rock



This material is based upon work supported by the Army Research Office under Award number: W911NF-20-1-0262. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Army Research Office.

Collaboratorium for Social Media and Online Behavioral Studies

COSMOS is developing big data analytical tools to understand digital behaviors and forecast trends to achieve social good. With multi-year multi-million dollar funding from various federal and state agencies, COSMOS is able to bring together several international academic, industry, and government institutions as partners in this venture.



@cosmographers

<https://cosmos.ualr.edu/>

26 grants (total funding over \$45 million and \$10 million to COSMOS-UALR):

- Army Research Office
- Office of Naval Research
- Air Force Research Lab
- DARPA
- Department of State
- Department of Homeland Security
- National Science Foundation
- NATO
- Arkansas Research Alliance
- Jerry L. Maulden/Entergy Endowment



ArkansasResearchAlliance
Coming together to move Arkansas forward.



- Over 30 members
 - Undergraduate students,
 - Graduate students (MS, PHD)
 - Postdoctoral fellows
 - Administrative staff
- Over 20 graduated
 - Industry (Walmart, Acxiom, FirstOrion, Windstream, Dillard, Amazon, LinkedIn, HP, Cisco)
 - Academia
 - Pursuing higher education



@cosmographers

<https://cosmos.ualr.edu/>

Academics

- Arizona State University, Carnegie Mellon University, Creighton University, Emory University, University of Central Oklahoma, University of North Carolina-Chapel Hill, George Mason University, George Washington University, University of Pittsburgh, Penn State, University of Memphis, University of New Haven, University of Hawaii, University of Michigan, University of Southern California, West Virginia University, Vilnius University, National University of Singapore, University of Sydney

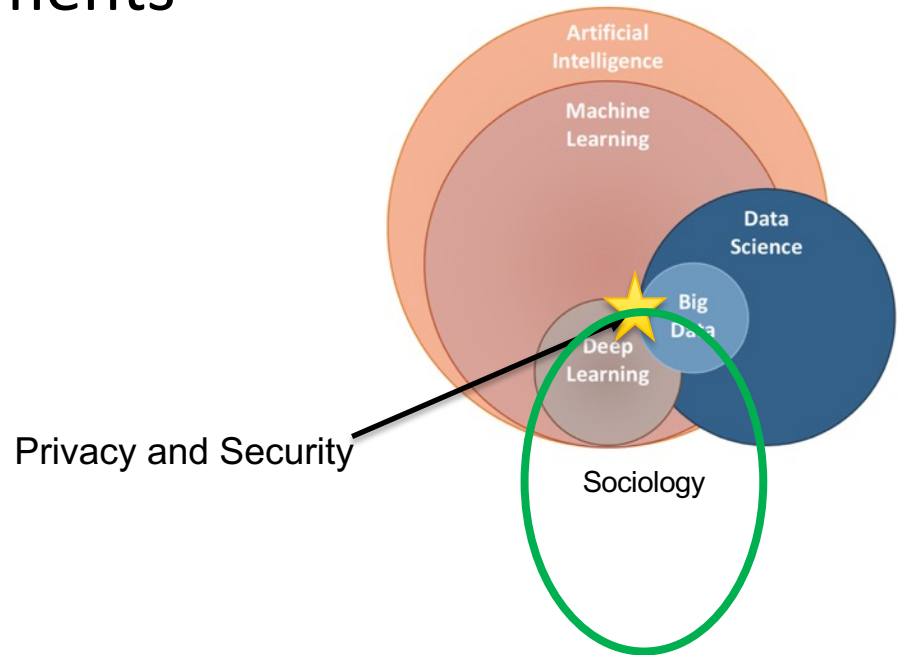
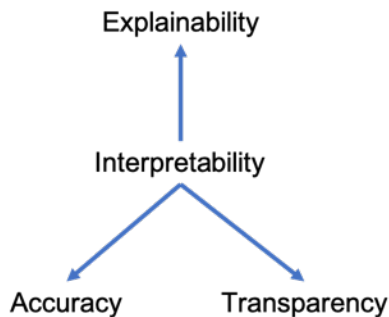
Industry

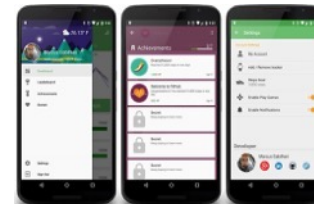
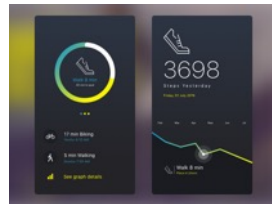
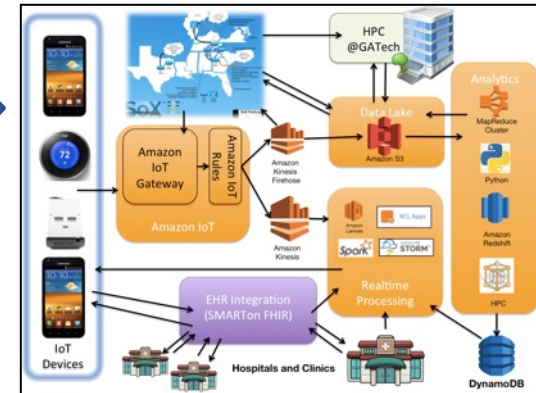
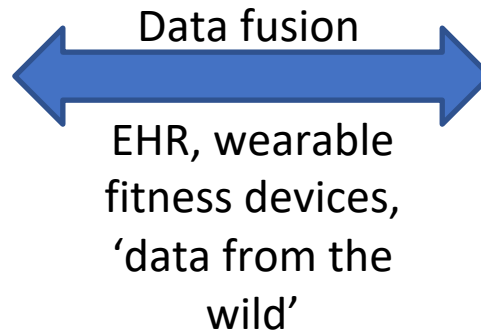
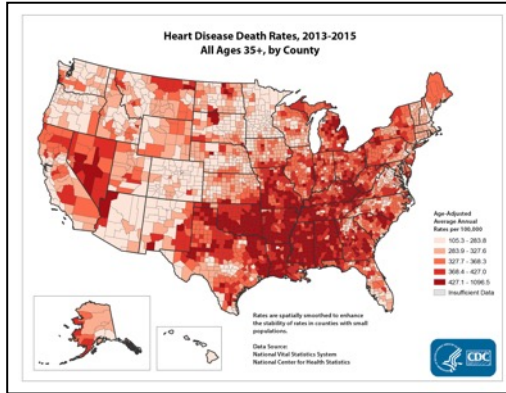
- Atlantic Council (DFRLab), Wal-Mart Inc., LinkedIn, Intelligent Automation Inc., Charles River Analytics, Galisteo Consulting Inc., CarleyTech, Netanomics, Kairos Inc., Bond.AI (fintech)

Government

- AR Attorney General's Office, US Defense Agencies, US ARCENT, EUCOM, US Cyber Command, Naval Postgraduate School, US SPAWAR, US Joint Information Operations Warfare Center, III-Marine Expeditionary Force (III-MEF), Army Research Lab, Office of Naval Research (Global), Air Force Research Lab, Singapore Government, Canadian PMO, NATO, StratCom COE, European Defense Agencies, FVEYS – intelligence coalition

- Smart Health and AI
- Campaigns and Movements
- Deviant Behaviors
- Social Cybersecurity





NSF-funded studies (over \$5,000,000) on adopting Big Data approach to address health disparities (CVD) across Southern US





Flash Mobs in Public Places



Saudi Women's Right to Drive protest



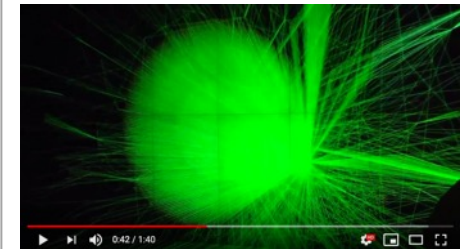
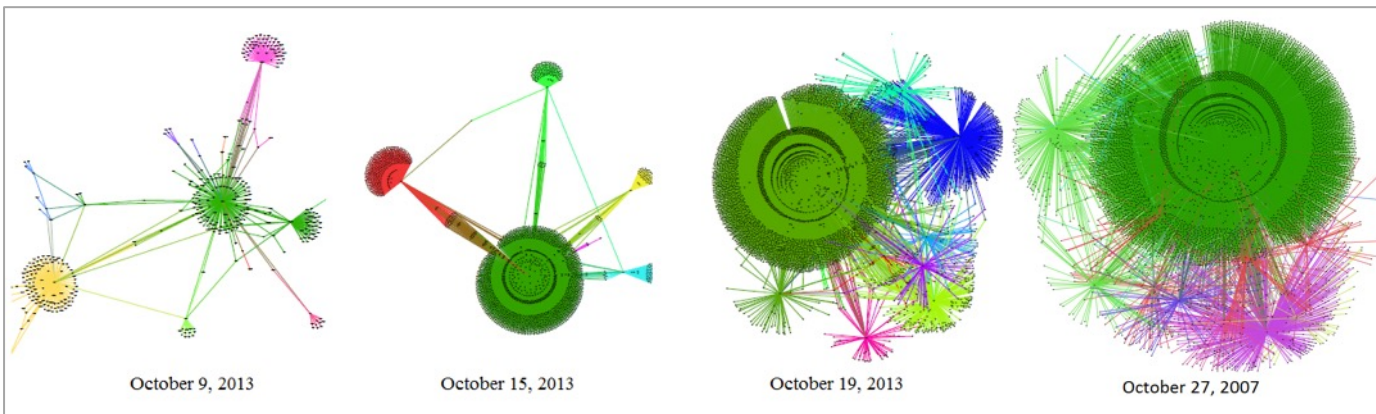
Autism Awareness Campaign



Starbucks Racial Controversy



2011 Arab Spring Social Movement



NSF and DoD funded projects (over \$1,000,000) on advancing understanding of cyber-collective actions





**Weaponizing
Narratives**



**Deviant Hackers
Networks (DHNs)**



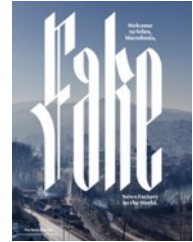
**ISIS
Recruitment
Radicalization
Propaganda**



Anti NATO Propaganda

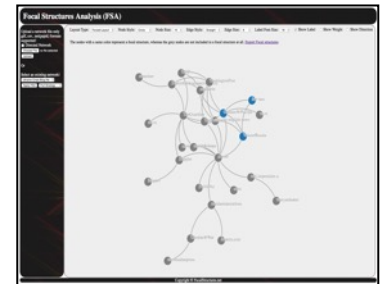
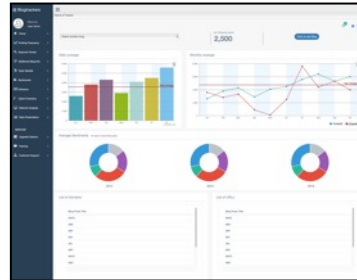


Anti-West Narrative



Fake News

**Several multi-year
DoD funded studies
totaling over \$10
million**



- Tracking anti-West, anti-EU, anti-NATO propaganda and influence campaigns
- Participated in various NATO exercises to assist public affairs in social media monitoring



Dragoon Ride
2015



Trident Juncture
2015



Brilliant Jump
2016



Anakonda
2016

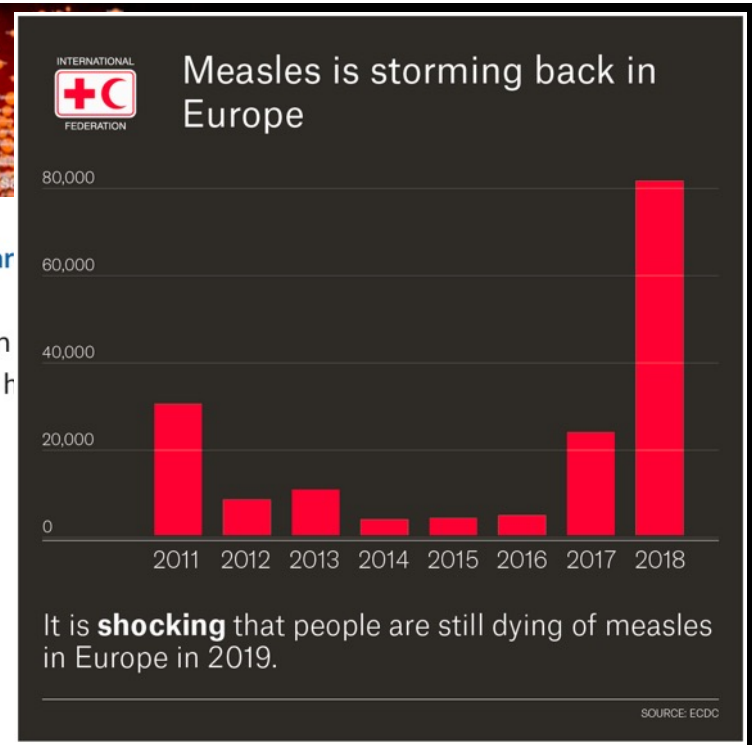
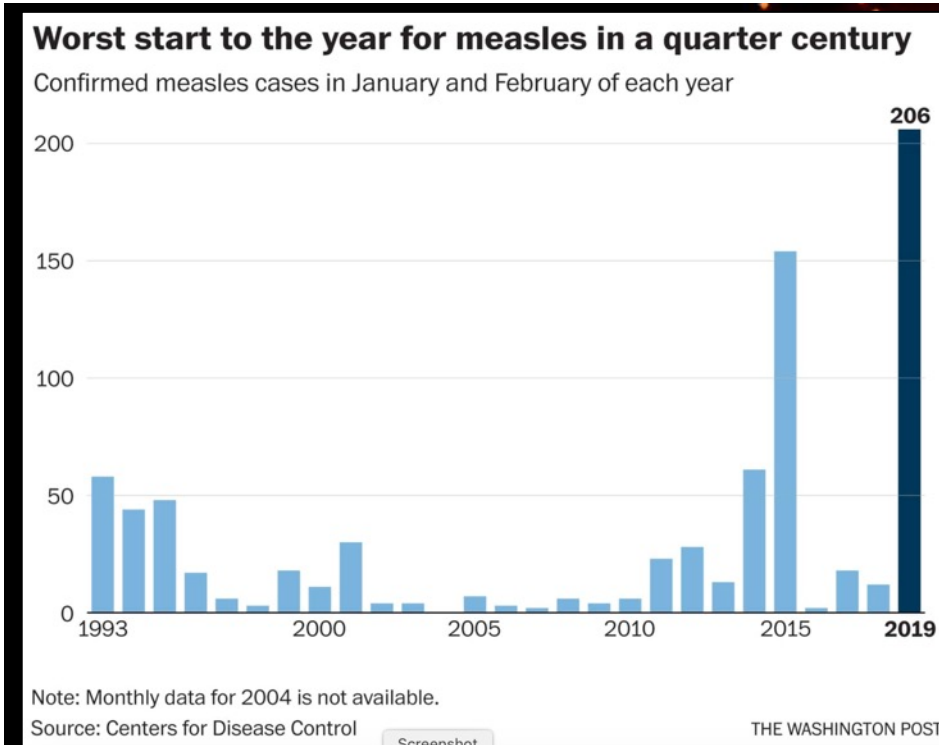


Trident Juncture
2018



Baltic Operations
2019

- Study terrorist and hacker groups
- Study 2019 Canadian Elections
- Monitor disinformation campaigns in the Asia Pacific region (Singapore Ministry of Communication and Information, Australian DoD, Univ. of Sydney)
- Monitor COVID-19 misinformation campaigns (FVEYS intelligence coalition, AR AG office)



The 206 cases in January and February already surpass annual totals for

IFRC Europe Regional Director, Simon Missiri, says the resurgence of measles is an increasingly worrying trend worldwide.

The New York Times

Dr. Google Is a Liar

Fake news threatens our democracy. Fake medical news threatens our lives.

By Haider Warraich
Dr. Warraich is a cardiologist.

Dec. 16, 2018


f t e r b

“Statins cause Cancer!”

Instagram

Search

PINK SALT VS. TABLE SALT



IG: connecting consciousness

- HAND-MINED IN THE HIMALAYAN MOUNTAINS, DYNAMITE USE IS FORBIDDEN
- CONTAINS 84 ESSENTIAL MINERALS REQUIRED BY THE HUMAN BODY
- A BENEFICIAL SOURCE OF MAGNESIUM
- PROMOTES HEALTHY PH BALANCE
- HELPS REGULATE BLOOD SUGAR LEVELS
- HELPS REGULATE BODY'S SLEEP CYCLE
- ZERO NUTRIENTS REMAIN AFTER HIGH HEAT 'PURIFICATION' PROCESS
- INCLUDES ANTI-CAKING COMPOUNDS
- CONTAINS FLUORIDE
- BAD SALT = BAD SODIUM, LEADING TO HIGH BLOOD PRESSURE AND EVEN CANCER
- WEAKENS BONES & BLOOD CIRCULATION

SHARE IF YOU BELIEVE PEOPLE SHOULD KNOW THE DIFFERENCE!

Follow

I've been using pink salt for nearly 3 years and it's been such an upgrade. Fasting Tip: If you get hungry, put a pinch of pink salt under your tongue

Do You Get Himalayan Pink Salt?

Load more comments

pakmcham 100%
earth first.
kingi89

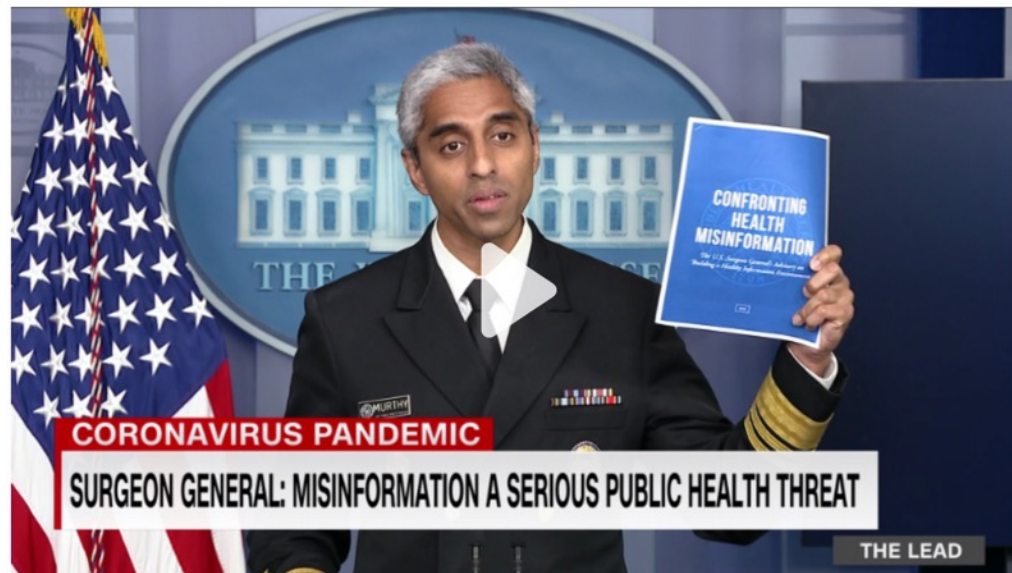
2,741 likes

OCTOBER 15, 2018

Add a comment...

Pink salt will “regulate your blood sugar and sleep cycle.”

- Dr Vivek Murthy, U.S. surgeon general, has released a public advisory calling misinformation a “serious threat to public health.”



CNN, July 16, 2021

COVID-19 misinfodemic presents an example of emerging cyber-social threats. While there are similarities with other disinformation campaigns (e.g., anti-NATO, anti-US, anti-EU, anti-West in Indo-Pacific region), COVID-19 disinformation campaigns have their nuances such as global and regional narratives; high topical diversity (health, policy, religion, geopolitical affairs, etc.); high volume, velocity, veracity, and variety of false narratives. COVID-19 misinformation tracker tool developed in collaboration with the Arkansas Office of the Attorney General to support detection, investigation, and mitigation of cross-platform COVID-19 disinformation campaigns and scams to assist policy makers. Our efforts demonstrate that when researchers coordinate with policy makers it can make a difference, especially when that coordination remains an ongoing process.



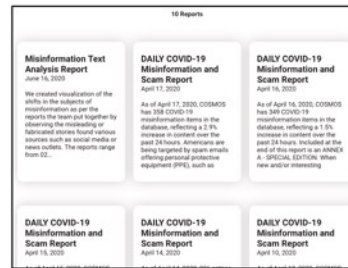
Cross-platform false narratives detected using developed socio-computational methodologies



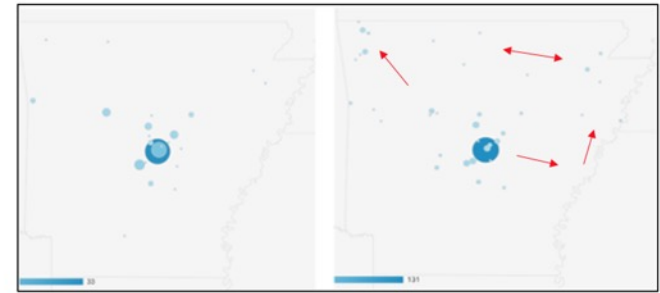
Education component of the effort



People notify us of scams and other misinformation cases not in our database which are then investigated



Daily reports to the AG's Office with our investigation results and recommendations for enhancing outreach/awareness



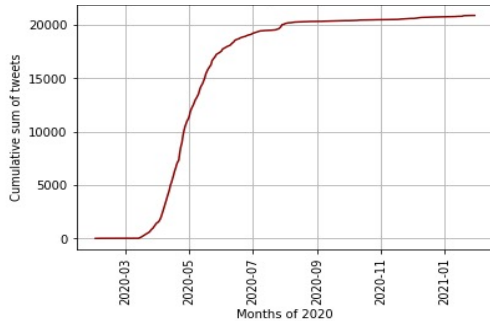
Increased penetration into rural areas of Arkansas as annotated by the arrows in the figure on right demonstrates the effectiveness of the tool and communications strategies.



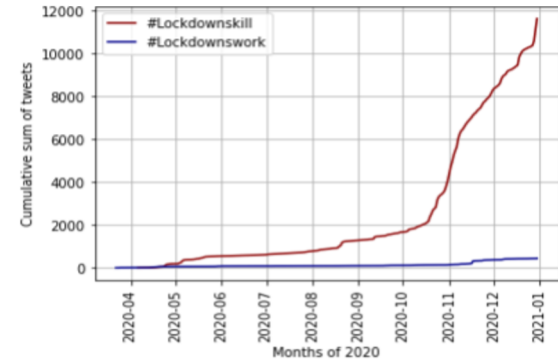
Arkansas Office of the Attorney General Press Release on our COVID-19 Misinfo Tracker

<https://cosmos.ualr.edu/covid-19>

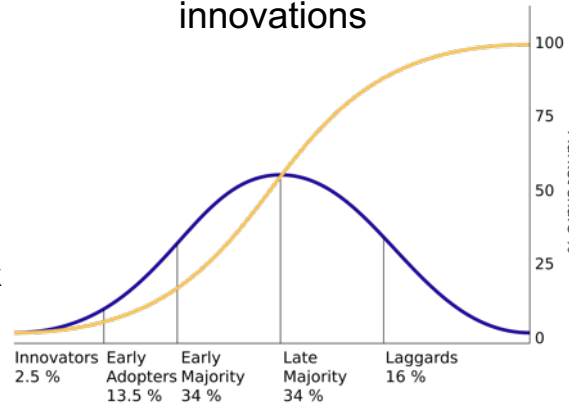
#BillGatesVirus



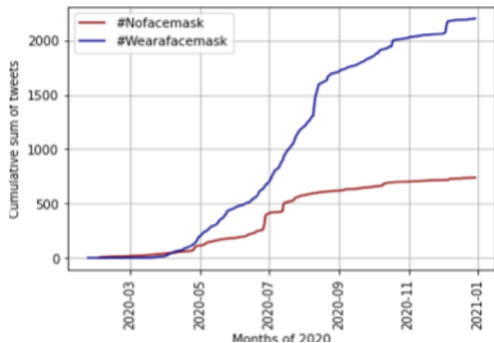
#Lockdownskill vs. #Lockdownwork



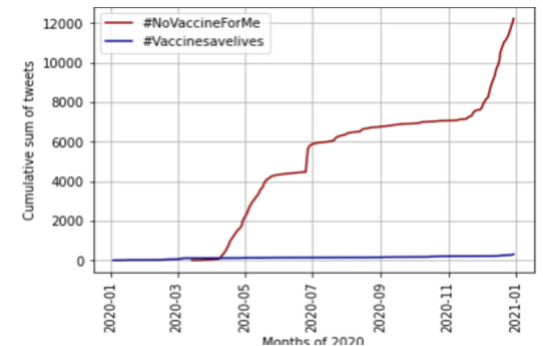
Theory of diffusion of innovations



#Nofacemask vs. #Wearfacemask



#NoVaccineForMe vs. #Vaccinesaveslives



Spann, B., Agarwal, N., Mead, E., and Williams, T. (2021) Using Diffusion of Innovations Theory to Study Connective Action Campaigns. Proceedings of the *International Conference on Social Computing, Behavioral-Cultural Modeling & Prediction, and Behavior Representation in Modeling and Simulation (SBP-BRiMS 2021)*, July 6-9, 2021, Washington D.C.

Logic of Connective Action – (Bennet, Segerburg, 2012)

- Original work on “connective action” – identified digital communication as an organizational process for mobilizations. Role of individuals
- Collective action = more formal organization, Connective Action = loosely based org., self-organized, coordination

Affordances – (Vaaast, et al., 2017)

- Related work using clustering methods and manual labeling to identify affordances within communities tweeting about the Gulf of Mexico Oil Spill in 2010

Interdependence – (Leonardi, 2013)

- Considered the affordance and interdependence relationships between users. Different interdependent relationships will have different use of technology affordances.

Diffusion of Innovations Theory – (Rogers, 1962)

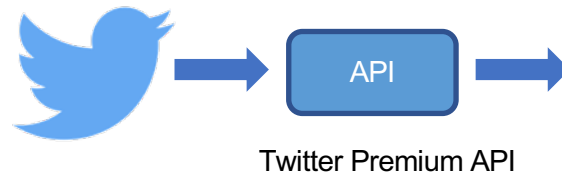
- Describes how new ideas and technology spread over time. Innovations must be widely adopted to reach critical mass. Follows an S-Curve function similar to the spread of information campaigns on social networks.

Critical Mass Theory – (Marwell & Oliver, 2003)

- Which aspects are important for achieving a critical mass to have successful collective action. Considered social ties, interest, resources.

Twitter data was collected from January 1, 2020 to Dec 31, 2020 around 9 Information Campaigns.

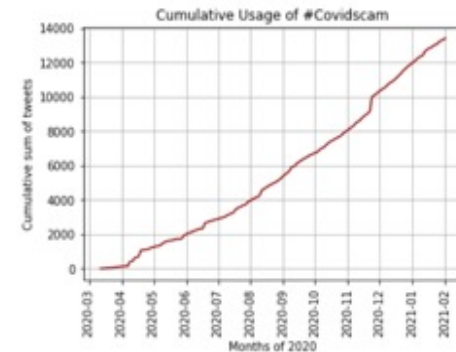
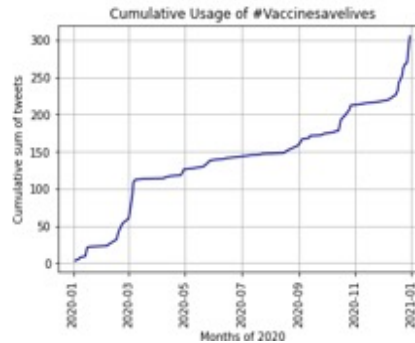
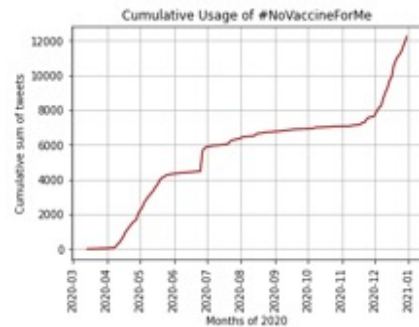
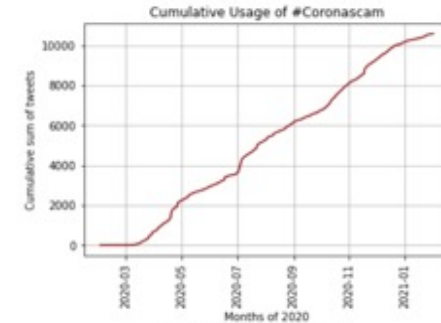
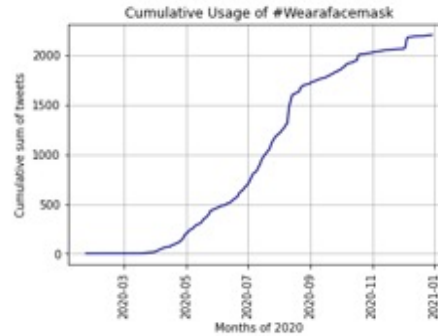
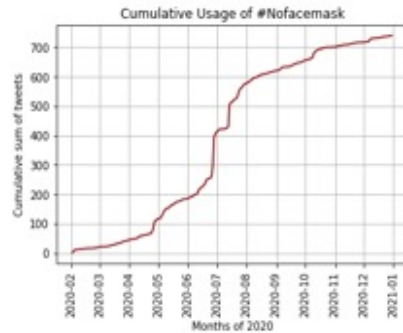
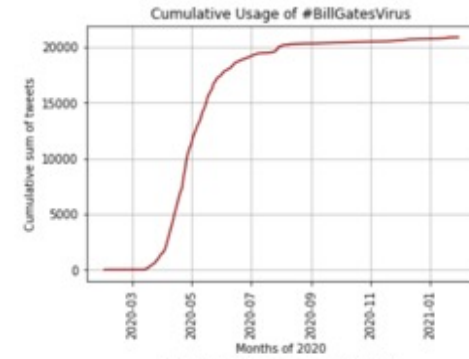
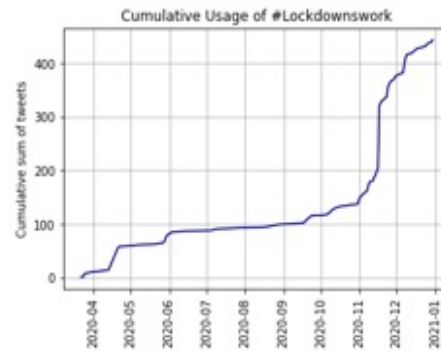
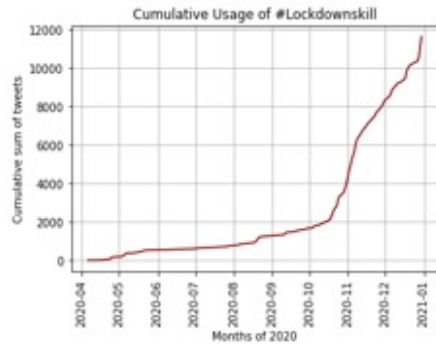
- 6 polarizing (pro vs anti) narratives
- 3 generic standalone Covid-19 campaigns
- 88,776 Tweets



Twitter Premium API

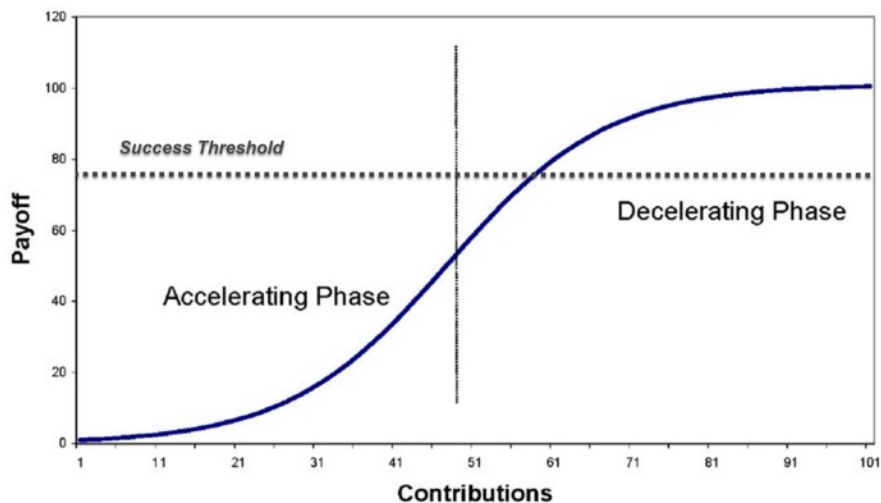
Hashtag	Number of Tweets
#Lockdownskill	11,630
#Lockdownwork	444
#Nofacemask	740
#Wearafacemask	2,200
#Novaccineforme	12,225
#Vaccinesavelives	305
#Covidscam	13,395
#BillGatesVirus	20,862
#Coronascam	10,592

S-curve Comparisons



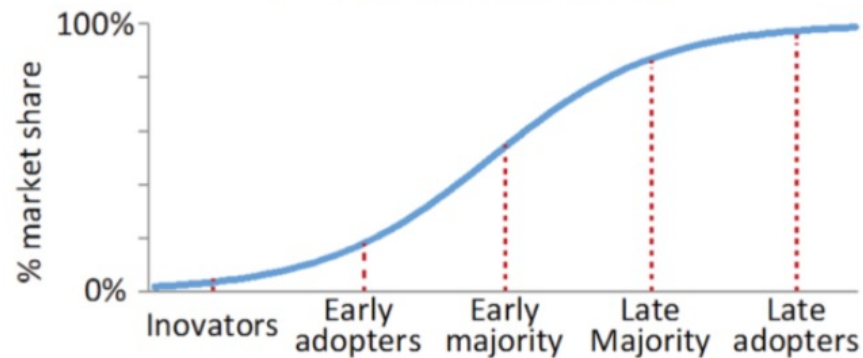
Characterization of the Overall Campaign Cycle

S-Shaped Production Function

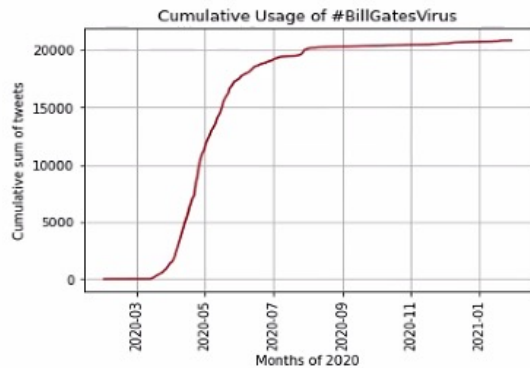


Characterization of User Adoption Cycle

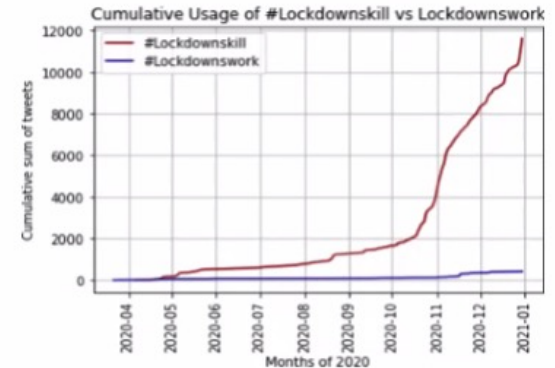
Diffusion of Innovations



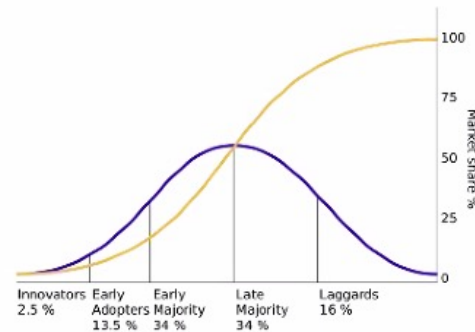
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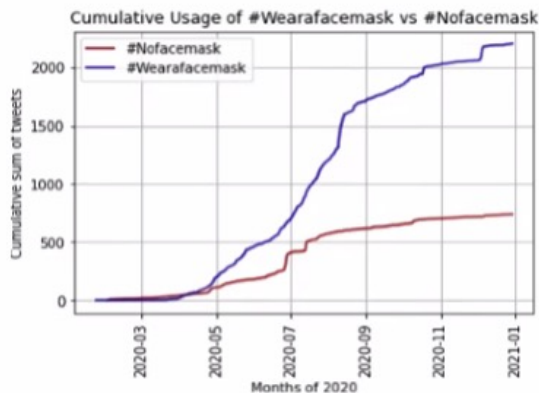
#Lockdownskill vs. #Lockdownswork



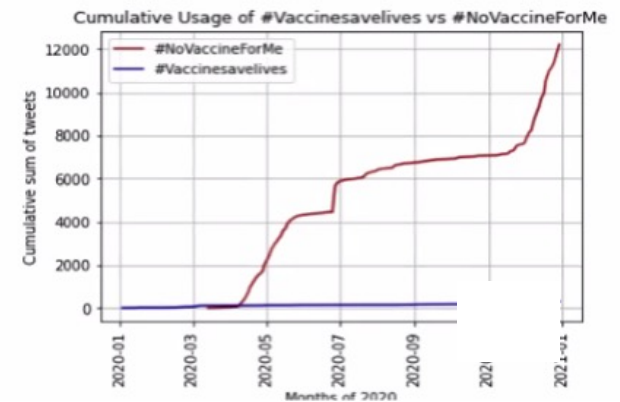
Theory of diffusion of innovations

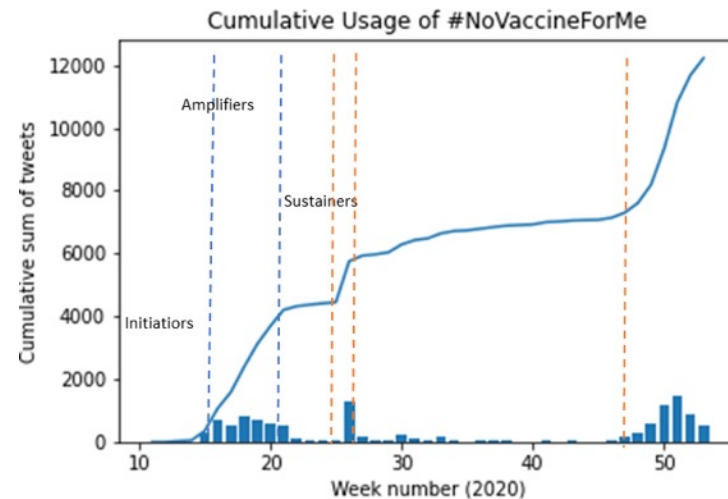
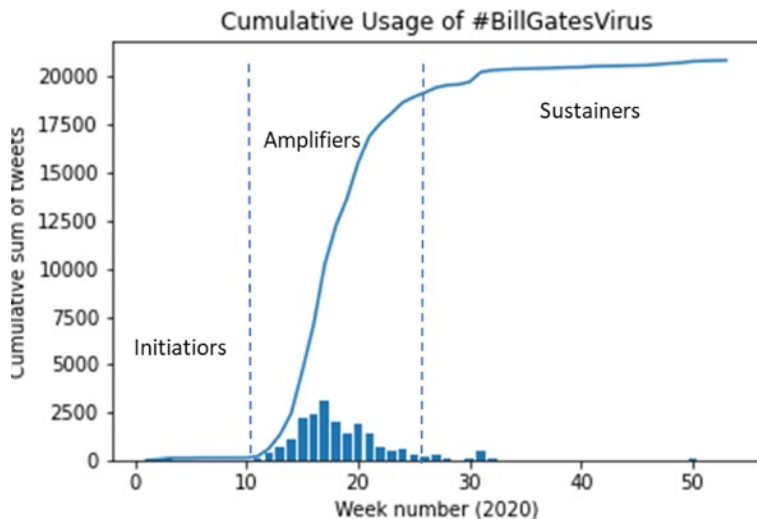


#Nofacemask vs. #Wearafacemask

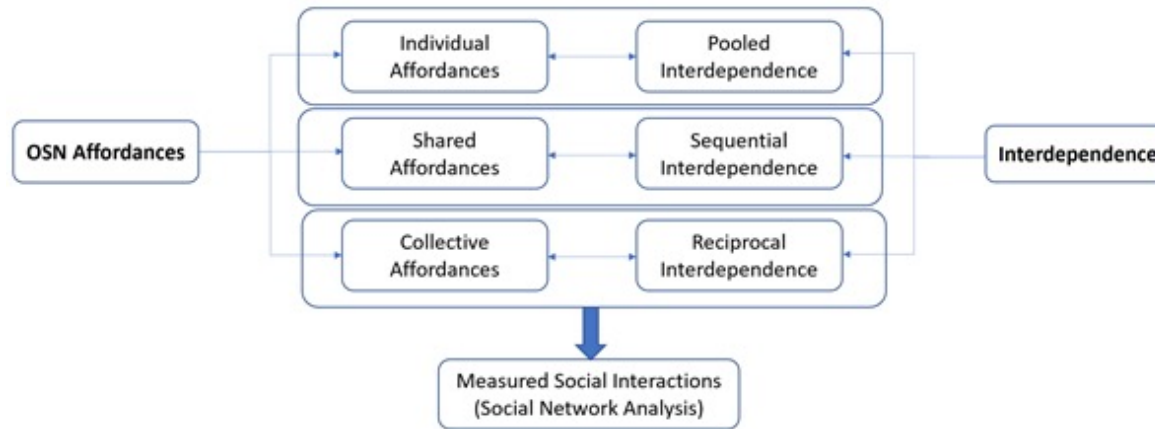


#NoVaccineForMe vs. #Vaccinesaveslives





	Innovators Stage 1 - 2.5%			Early Adopters Stage 2 - 13.5%			Early Majority Stage 3 - 34%			Late Majority Stage 4 - 34%			Late Mass Stage 5 - 16%		
	Count of Tweets	Total Time (hours)	Slope	Count of Tweets	Total Time	Slope	Count of Tweets	Total Time	Slope	Count of Tweets	Total Time	Slope	Count of Tweets	Total Time	Slope
LockdownsKill	291	722	0.40	1,861	4,486	0.41	5,815	5,159	1.13	9,769	6,144	1.59	11,630	6,439	1.81
Nofacemask	18	640	0.03	118	2,210	0.05	370	3,541	0.10	622	5,176	0.12	740	7,961	0.09
NoVaccineForMe	306	699	0.44	1,956	1,117	1.75	6,112	3,122	1.96	10,268	6,705	1.53	12,224	7,004	1.75
Vaccinesaveliv	8	251	0.03	49	1,202	0.04	153	5,777	0.03	257	8,514	0.03	306	8,690	0.04
Wearafacemas	55	551	0.10	352	1,527	0.23	1,100	3,127	0.35	1,848	4,759	0.39	2,200	6,933	0.32
BillGatesVirus	522	1,233	0.42	3,338	1,636	2.04	10,431	2,082	5.01	17,524	2,922	6.00	20,862	8,734	2.39
AVERAGE			0.24			0.76			1.43			1.61			1.06



Individual Affordances → Pooled Interdependence

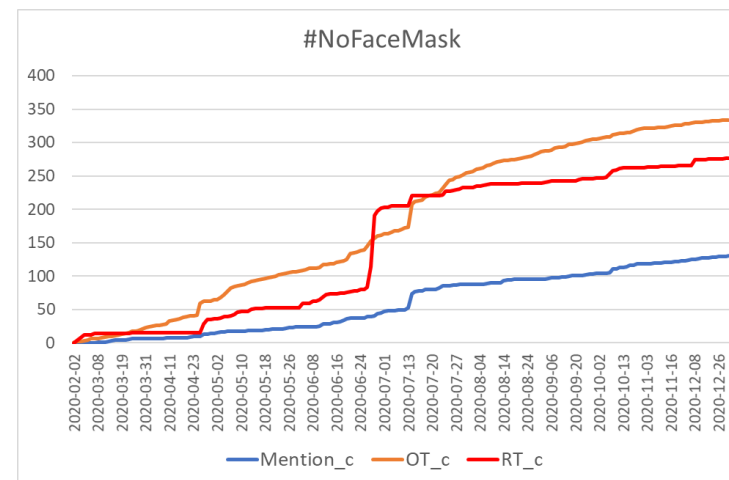
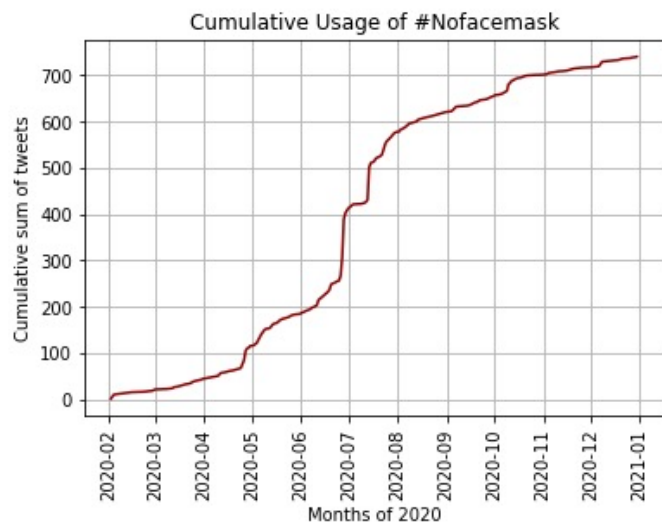
→ *Original Tweet (Outdegree + DCFM power)*

Shared Affordances → Sequential Interdependence

→ *Retweets (Outdegree Centrality)*

Collective Affordances → Reciprocal Interdependence

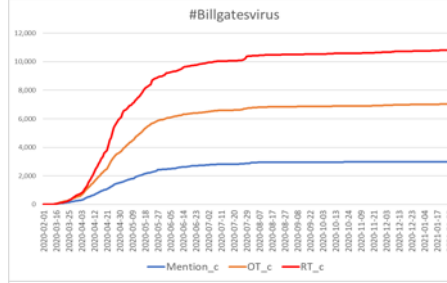
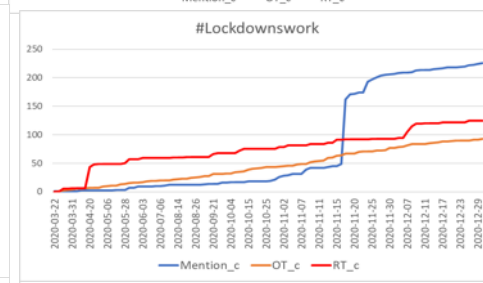
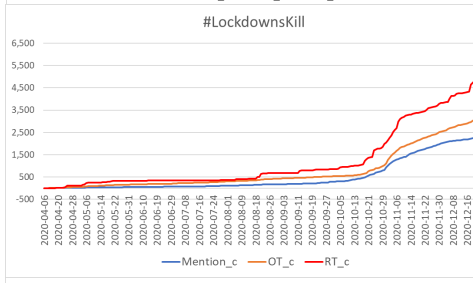
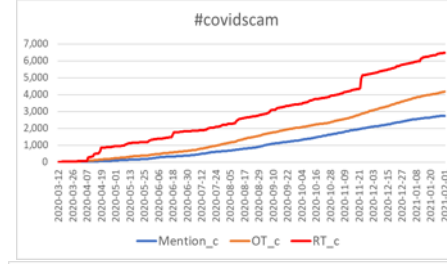
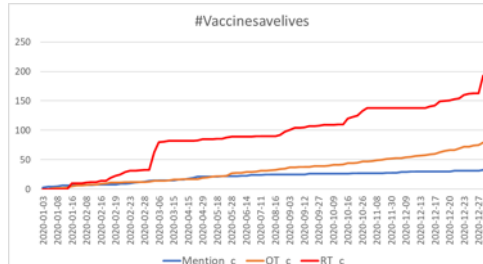
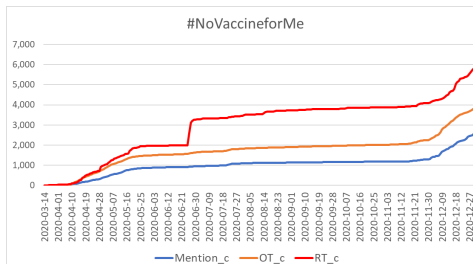
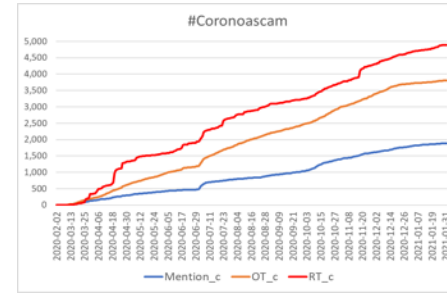
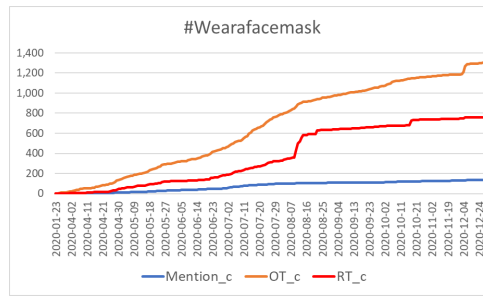
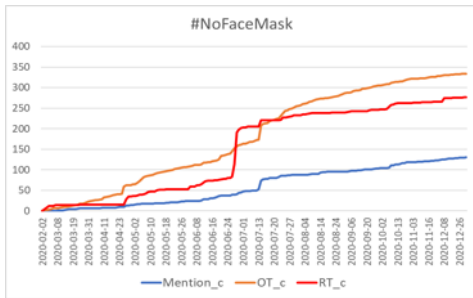
→ *@Mentions + Reply's (Indegree + Outdegree)*



Does this conceptual framework distinguish between individualized, shared, or collective affordances and interdependencies?

Table 1. Tweet counts for various COVID-19 hashtags from January 1 to December 31, 2020.

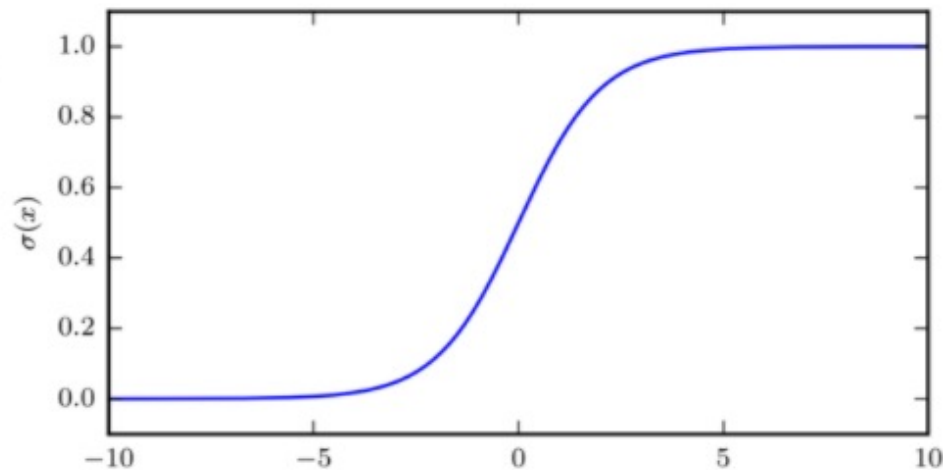
Hashtag	Number of Tweets	Original Tweets	Number of RTs	Number of Mentions
#Lockdownskill	11,630	3,260 (28%)	5,976 (51%)	2,394 (21%)
#Lockdownswork	444	93 (2%)	125 (28%)	226 (51%)
#Nofacemask	740	334 (45%)	276 (37%)	130 (18%)
#Wearafacemask	2,200	1,300 (59%)	760 (35%)	140 (.06%)
#Novaccineforme	12,225	3,827 (31%)	5,816 (48%)	2,582 (21%)
#Vaccinesavelives	305	79 (26%)	193 (63%)	33 (11%)
#Covidscam	13,395	4,165 (31%)	6,482 (48%)	2,748 (21%)
#BillGatesVirus	20,862	2,993 (14%)	10,826 (52%)	7,043 (34%)
#Coronascam	10,592	3,810 (36%)	4,893 (46%)	1,889 (18%)



- Develop a model that gives us a probability to adopt or not adopt connective action.

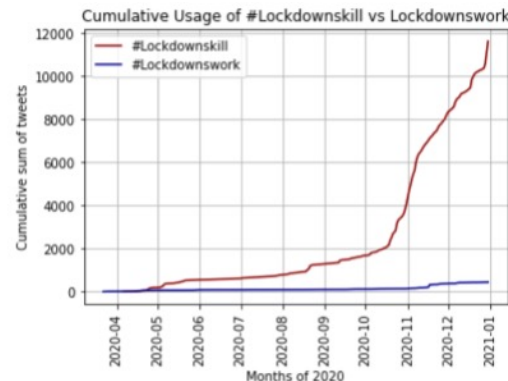
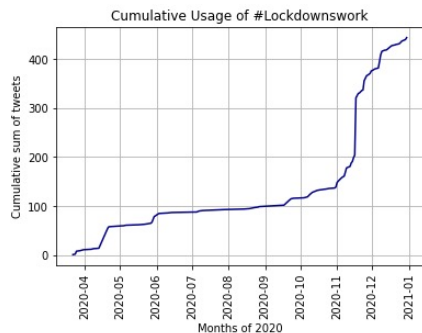
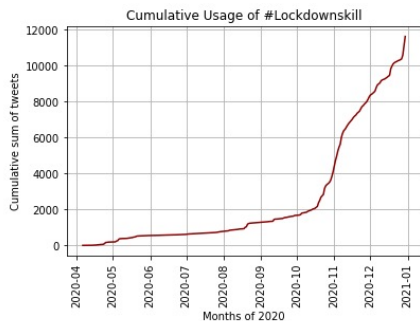
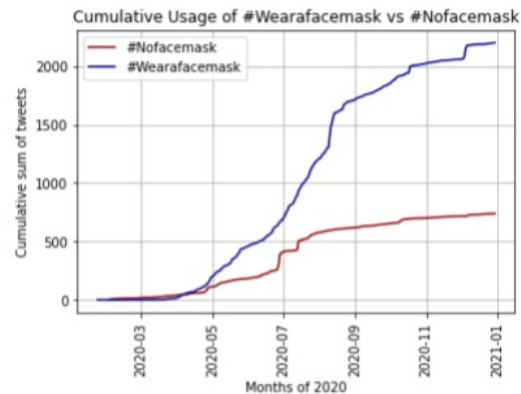
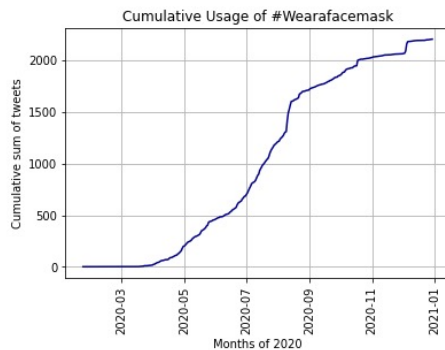
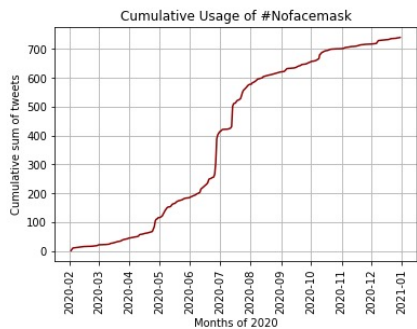
Logistic Sigmoid function

- The Logistic Sigmoid (σ) is the most common **activation function** used in major machine learning algorithms such as Logistic Regression and Neural Networks.
- It follows the S curve which saturates to 1 or 0 when input is very large or very small respectively.
- It converts a value x into a probability of something happening, such as, the probability p of rainfall given the weather conditions.
- If $p \geq 0.5$, the output is marked as TRUE. If $p < 0.5$, output is FALSE.

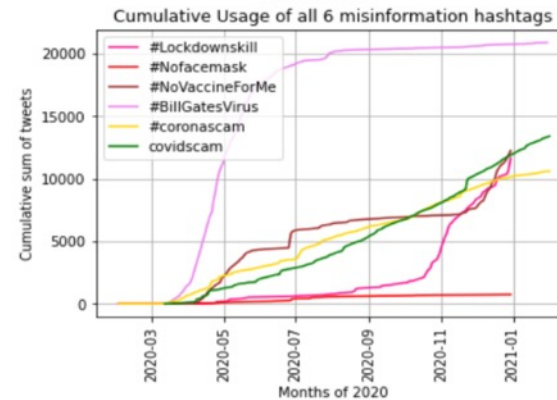
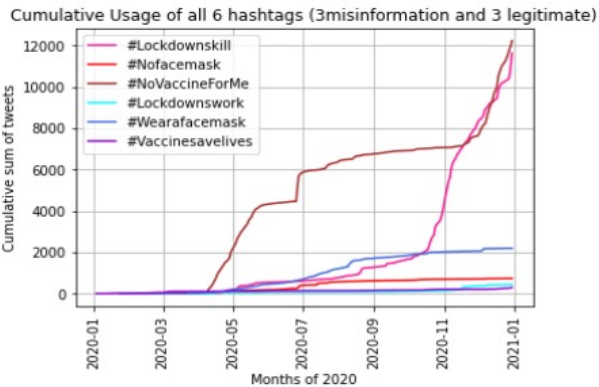
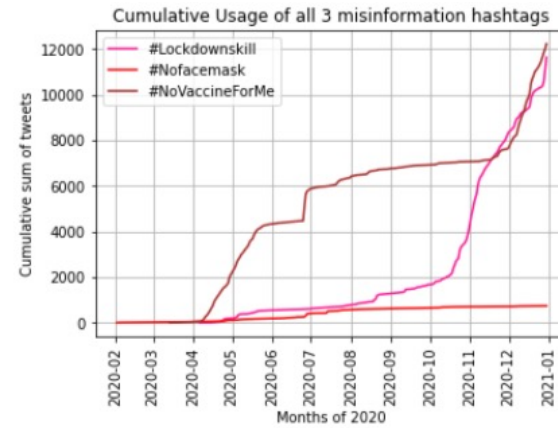
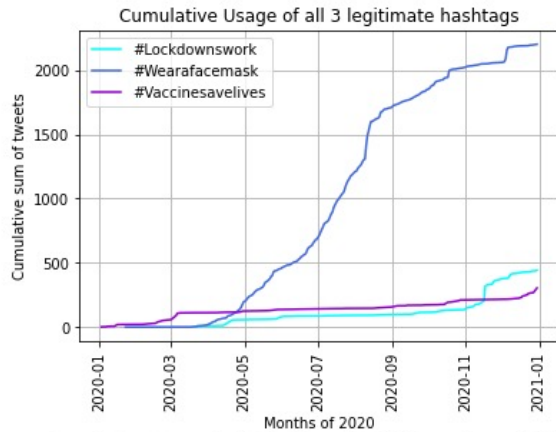


$$\sigma(x) = \frac{1}{1 + \exp(-x)}$$

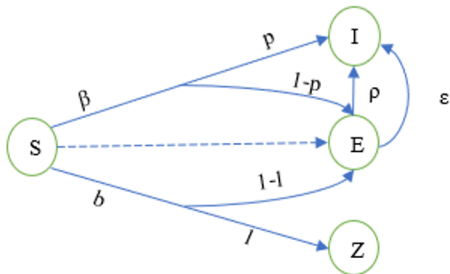
Probability of event



Comparing Campaigns



How misinformation spreads? Leveraging epidemiological model.
 (Maleki, Agarwal, et al. 2021) European Conference of Operations Research (EURO) 2021



SEIZ model

- S: Susceptible
- E: Exposed
- I: Infected
- Z: Skeptic

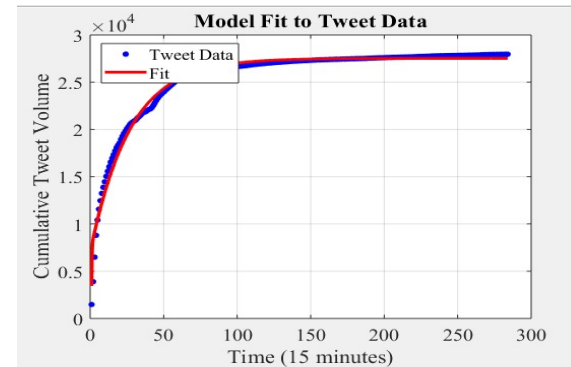
$$\frac{dS}{dt} = -\beta S \frac{I}{N} - bS \frac{Z}{N}$$

$$\frac{dE}{dt} = (1-p)\beta S \frac{I}{N} + (1-l)bS \frac{Z}{N} - \rho E \frac{I}{N} - \epsilon E$$

$$\frac{dI}{dt} = p\beta S \frac{I}{N} + \rho E \frac{I}{N} + \epsilon E$$

$$\frac{dZ}{dt} = lbS \frac{Z}{N}$$

Parameter	DEFINITION
β	Contact rate between S and I.
b	Contact rate between S and Z.
ρ	Contact rate between E and I.
p	Probability of S to I given contact with I.
$1-p$	Probability of S to E given contact with I.
ϵ	Transition rate of E to I (Incubation rate).
l	Probability of S to Z given contact with Z.
$1-l$	Probability of S to E given contact with Z.

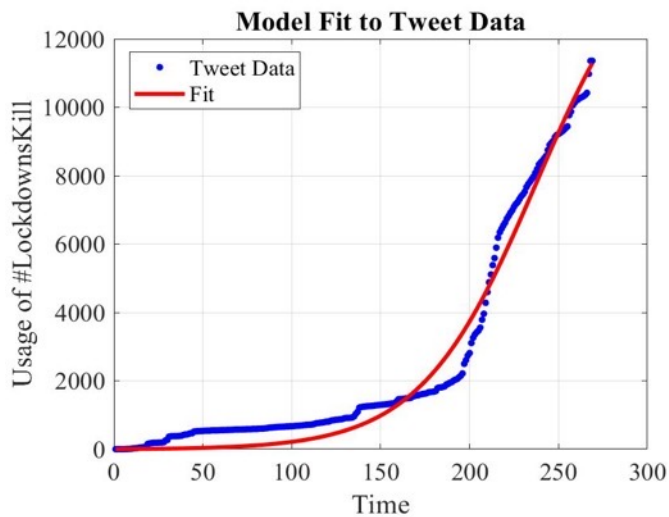


Misinformation regarding the unrest in Washington, D.C. in March 2020 propagated using the #DCblackout hashtag

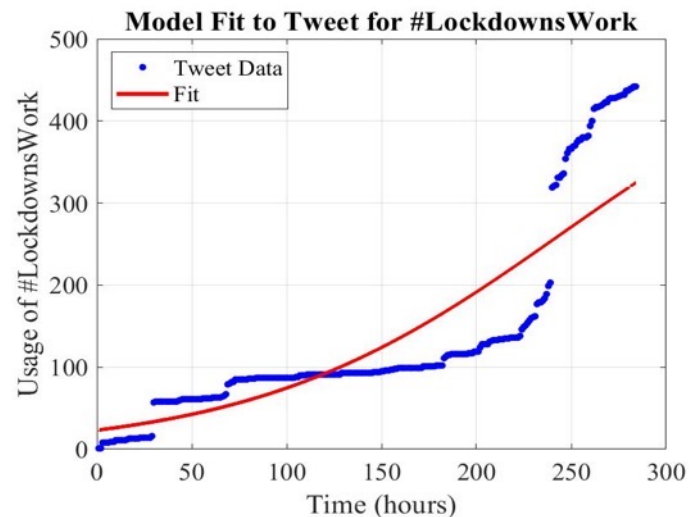
Error = 0.019

Maleki, M., Arani, M., Buchholz, E., Mead, E., and Agarwal, N. (2021) Applying an Epidemiological Model to Evaluate the Propagation of Misinformation and Legitimate COVID-19-related Information on Twitter. Proceedings of the *International Conference on Social Computing, Behavioral-Cultural Modeling & Prediction, and Behavior Representation in Modeling and Simulation (SBP-BRIMS 2021)*, July 6-9, 2021, Washington D.C.

Lockdown hashtags

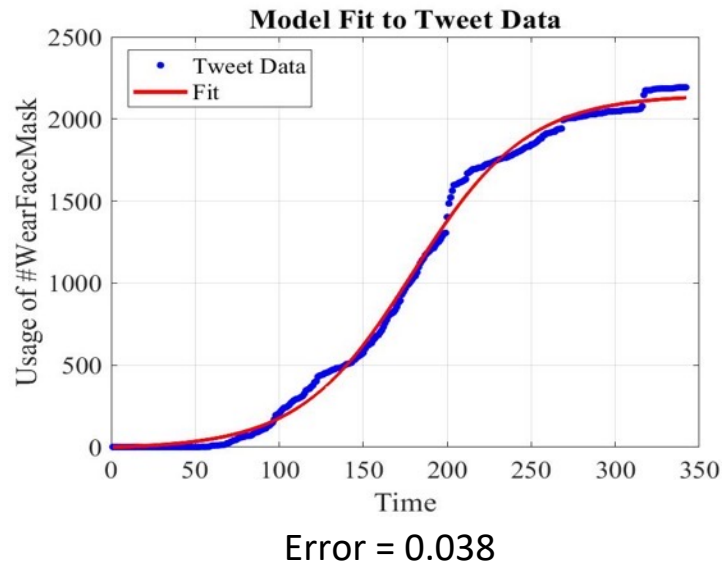
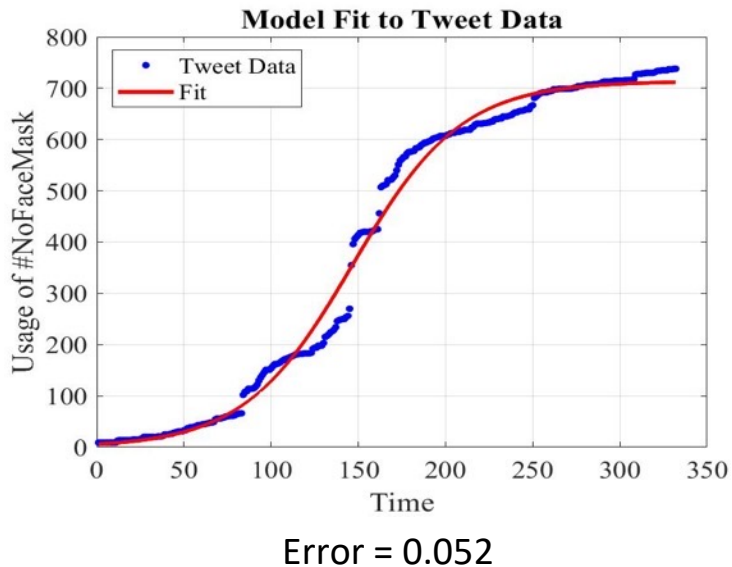


Error = 0.115

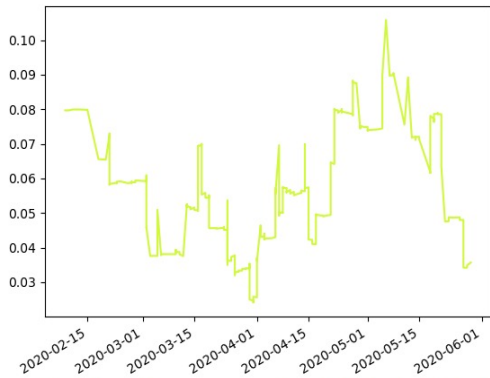


Error = 0.315

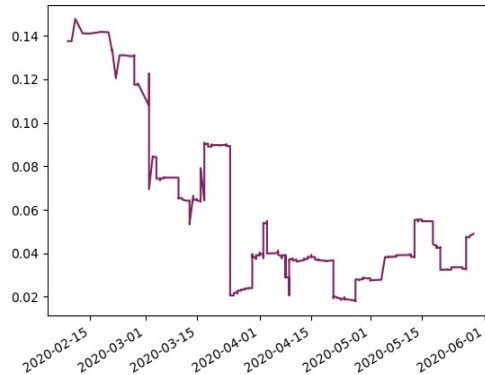
Face mask hashtags



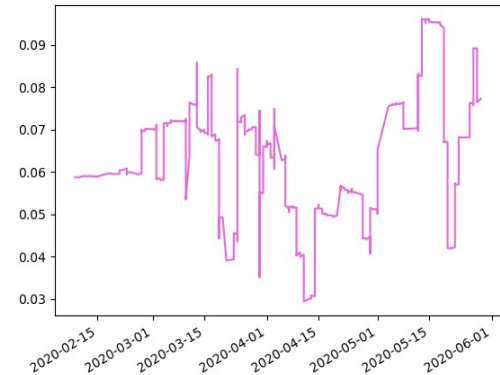
Misinformation Content Themes



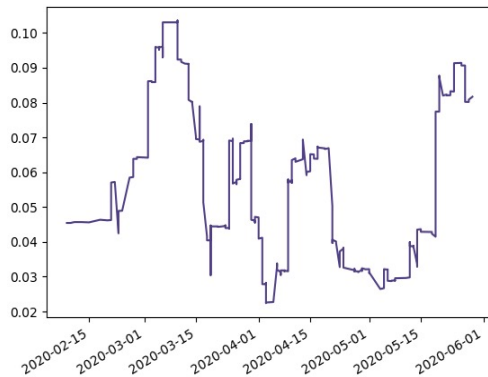
flu, china, die, weapon, outbreak, biological, deaths



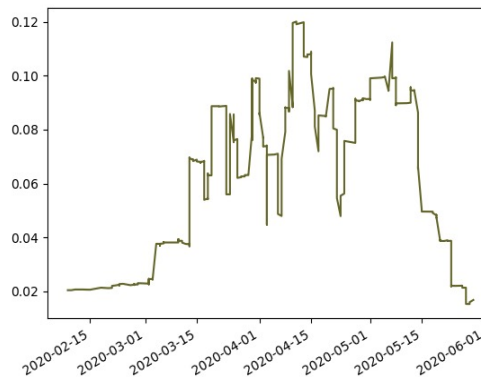
china, government, lab, russia, use, created



pandemic, vaccine, country, gates, testing, economic, american



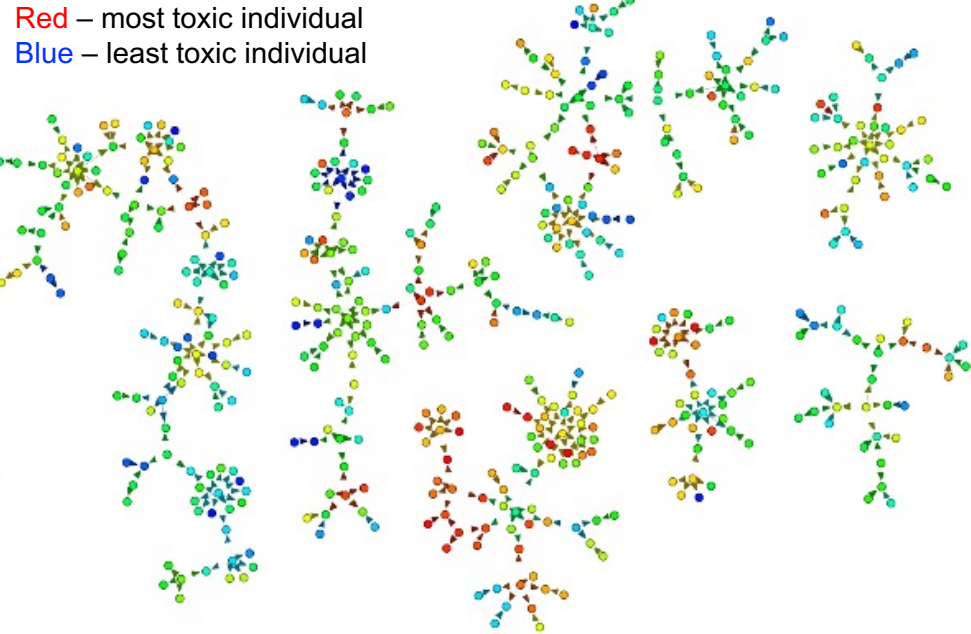
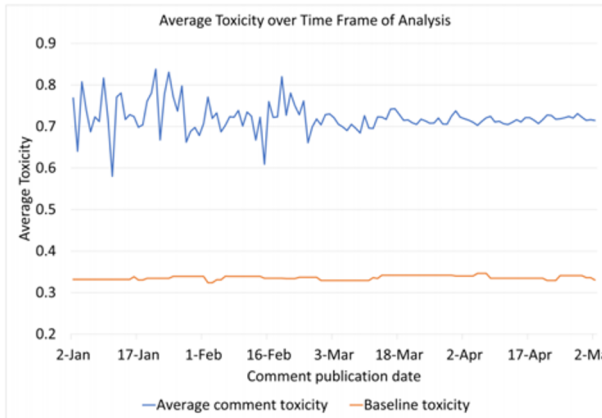
virus, hydroxychloroquine, outbreak, countries, cases, water, russia



pandemic, new, scam, kill, infection, government, spread

HUSO 2021

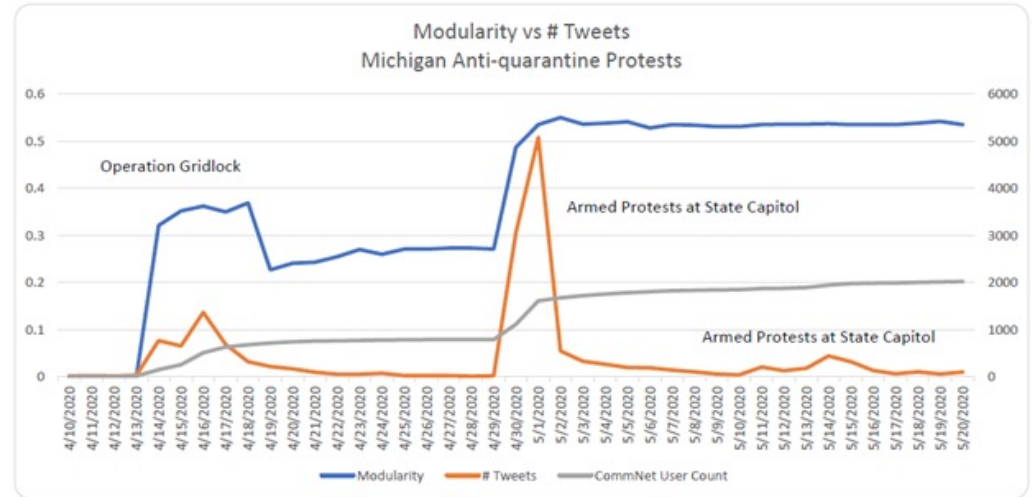
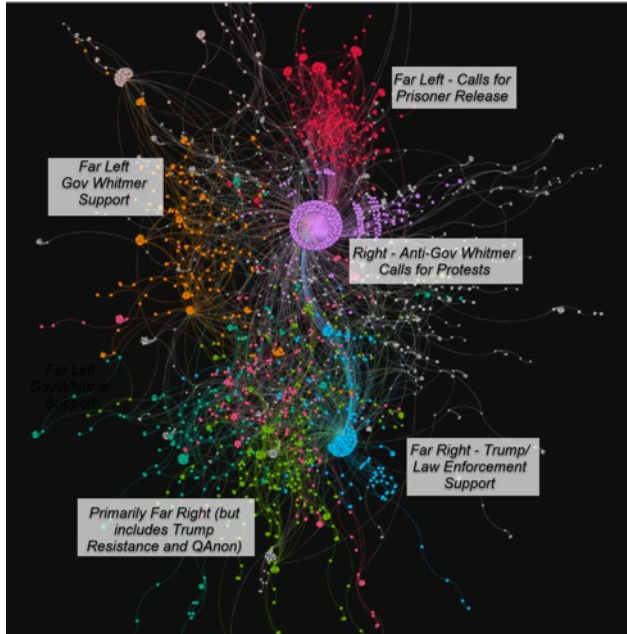
COVID-19 misinformation themes pushed on multiple platforms (blogs, twitter, YouTube, facebook, and other non-mainstream social media platforms). Recurring/periodic themes such as vaccine hesitancy, alternate medicines, conspiracy theories, etc. allow proactive communication strategies and policymaking to detect and mitigate emerging cyber-social threats.



Experimental simulation	Toxicity score	Percentage reduction
Removal of top 10 users with high Betweenness centrality	0.720981759	0.21
Removal of top 10 users with high PageRank centrality	0.722317191	0.02
Removal of users with toxicity scores greater than 0.8	0.641927323	11.15

Toxicity analysis on YouTube commenters. Toxic discourse causes disruption and polarization/segregation among communities, as seen above. We demonstrate that by removing highly toxic users from a network, hate speech reduces, online discourse improves, and fractured communities heal. Our findings offer guidance to policymakers within each online social network to make informed decisions about the information environment and derive appropriate and timely countermeasures to continue providing a healthy platform for their users.

Obadimu, A., Khaund, T., Mead, E., Marcoux, T., and Agarwal, N. (2021) Developing a Socio-Computational Approach to Examine Toxicity Propagation and Regulation in COVID-19 Discourse on YouTube. *Information Processing and Management Special issue on Dis/Misinformation Mining from Social Media*. Vol. 58, Issue 5, 2021. Elsevier. DOI: 10.1016/j.ipm.2021.102660

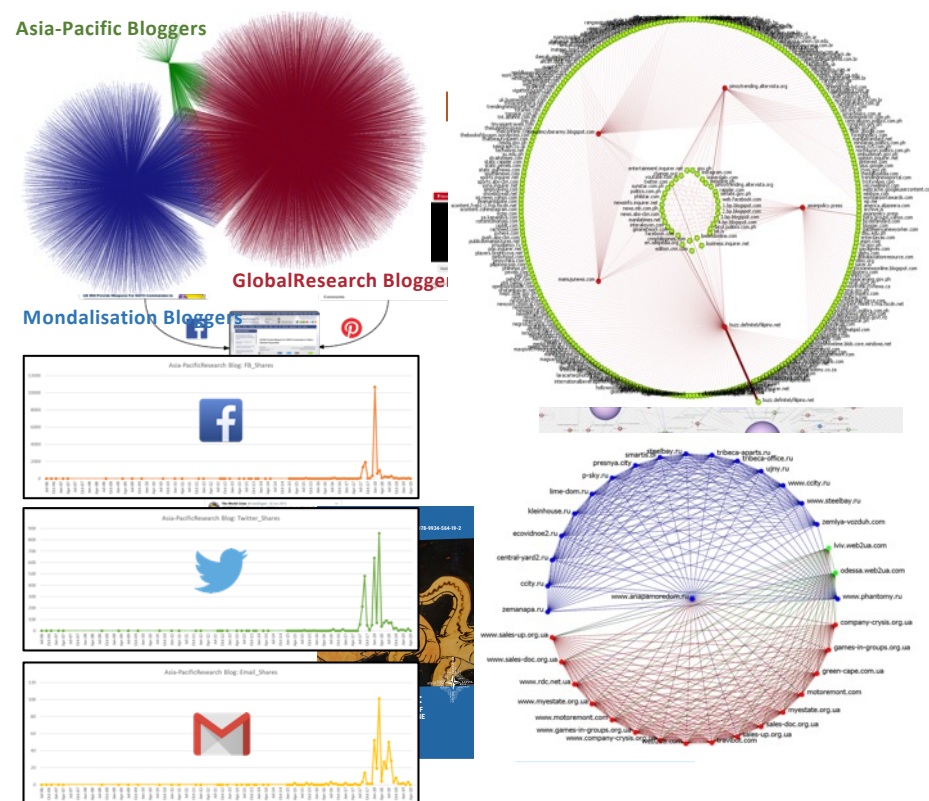


Michigan anti-lockdown protest network
 #LetMiPeopleGo, #MiLeg, #Endthelockdown,
 #MichiganProtest; April 1 to May 20; 16,383 tweets; 3,632 nodes; 382 groups (focused on 5 most powerful groups)
FSA/DCFM model showed powerful coordination among far-right twitter groups including QAnon calling for protest and actions against Gov. Whitmer as compared to far-left groups. FBI later unraveled a far-right wing plot to kidnap Gov. Whitmer.

Communities	Political Category	No. of Users in Each Community	No. of Nodes	No. of Edges	Modularity	Average Weighted Degree	Average Betweenness Centrality	DCFM Power
Largest Community	Right	459	510	526	0.294	1.457	0	90.88
Second Community	Right	152	284	419	0.578	2.771	0	77.12
Third Community	Right	212	269	322	0.468	1.792	0	280.98
Fourth Community	Left	78	204	491	0.422	9.779	24.26	10.36
Fifth Community	Left	115	243	339	0.608	7.683	0.16	28.94

Table Y1 - Top 5 Largest Modularity-Based Communities

- Cross platform orchestration
 - Growing use of niche platforms
- Communities and coordination
 - Flash mob style coordination
 - Blogger communities
 - Coordinated clickbait (a.k.a. blog farms, information laundering)
 - Computational (AI) propaganda – coordinated *deepfakes*
- Algorithmic manipulation
 - Machine driven communications (MADCOMs) (bots, botnets, social bots, etc.)



$$\max \sum_{i=1}^n \delta_i \quad (1)$$

Subject to

$$\delta_i = \{d\bar{c}_1^i \leq d\bar{c}_2^i \leq d\bar{c}_3^i \leq \dots \leq d\bar{c}_i^i\} - \bar{d}c_j^Q \quad \forall i, j \quad (2)$$

$$d_i^c = \sum_j m_{ij} \quad \forall i \quad (3)$$

$$d_i^c \geq 2 \quad \forall i \quad (4)$$

$$D_G^L = \frac{1}{n} \sum_{i=1}^n d_i^c \quad \forall i \quad (5)$$

$$D_G^L < d_i^c \leq D_G^U \quad \forall i \quad (6)$$

$$a_i^c = \frac{(\# \text{ of Triangles}) \times 3}{\# \text{ of Connected Triples of Nodes}} \quad \forall i \quad (7)$$

$$AC_G^L = \frac{1}{n} \sum_{i=1}^n a_i^c \quad \forall i \quad (8)$$

$$AC_G^L < a_i^c \leq AC_G^U \quad \forall i \quad (9)$$

$$\bar{c}_v = \{\bar{c}_1, \bar{c}_2, \bar{c}_3, \dots, \bar{c}_j\} \quad \forall i, j \quad (10)$$

$$\bar{c}_{\delta_{n \times k}} = \bar{c}_{\delta_i} \quad \forall i \quad (11)$$

$$F = \{c_0, c_j^Q, c_{j+1}^Q, \dots, c_k^Q\} \quad \forall j, k \quad (12)$$

$$\max \sum_{j=1}^n e_j^M \quad (13)$$

Subject to

$$e_j^M = \{e_1, e_2, e_3, \dots, e_j\} \quad \forall j \quad (14)$$

$$\delta_j = \{\bar{c}_1, \bar{c}_2, \bar{c}_3, \dots, \bar{c}_n\} - \bar{c}_{\delta_{n \times k}} \quad \forall i, j \quad (15)$$

$$B = A_{ij} - \frac{dd^T}{2g} \quad \forall i, j \quad (16)$$

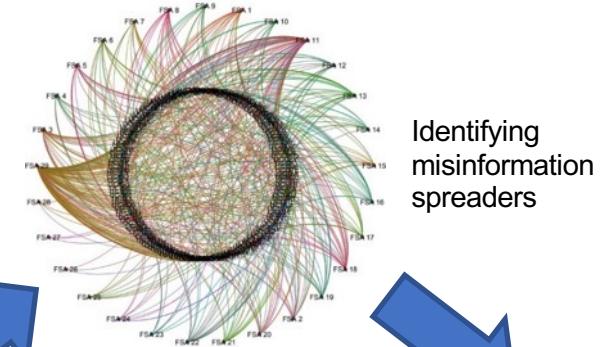
$$\xi_j = \{\bar{c}_{\delta_i} \cup \delta_j | \bar{c}_{\delta_i} \neq \delta_j\} \quad \forall i, j \quad (17)$$

$$e_j = \frac{1}{2m} \text{Tr}(\xi_j B \xi_j^T) \quad \forall j \quad (18)$$

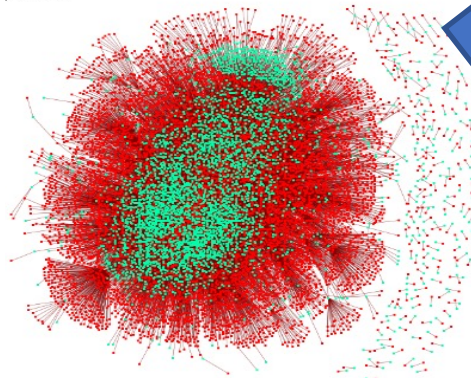
$$e_{\square}^L \leq e_j \leq e_{\square}^U \quad \forall j \quad (19)$$

$$c_j^Q = \max\{e_1, e_2, \dots, e_j\} \quad \forall j \quad (20)$$

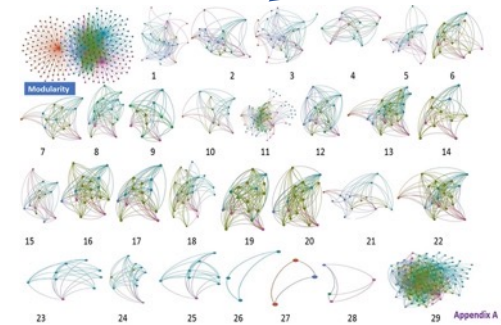
Multi criteria optimization formulation to identify disinformation spreaders. (Alassad, Agarwal, et al., 2021) Central European Journal of Operations Research, Springer



Identifying misinformation spreaders



YouTube COVID-19 misinformation video-user network

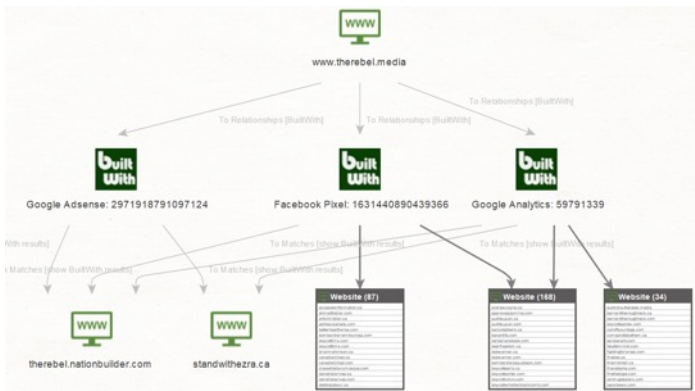


Sorted on effectiveness

Alassad, M., Hussain, M., and Agarwal, N. (2021) Decomposition Optimization Method for Locating Key Sets of Commenters Spreading Conspiracy Theory in Complex Social Networks. *Central European Journal of Operations Research*. Springer. DOI: 10.1007/s10100-021-00738-5.

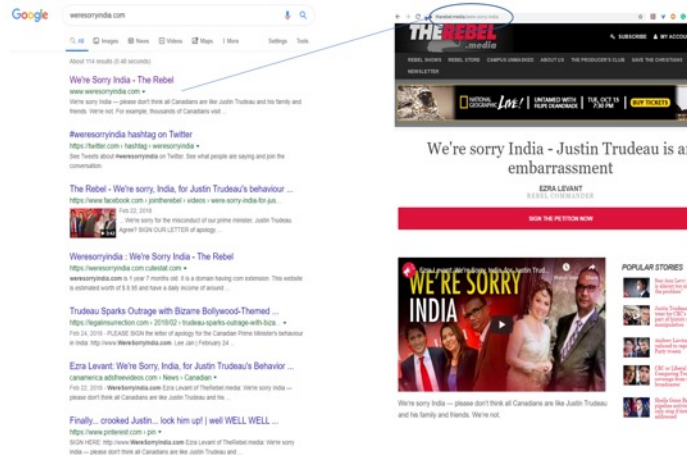
Canadian Federal Elections 2019

One such fake website “weresorryindia.com” amplified anti-Trudeau narrative suggesting he is not a friend of the Canadian-Indian community. The website tops the results in search engines.



Website (87)	Website (168)	Website (34)
Entity: justiceforchelsey.com	Entity: andrewcoyne.ca	Entity: australia.therebel.media
Entity: justiceforonki.com	Entity: approvejamie.com	Entity: bernardtheroughneck.ca
Entity: justiceforonki.com	Entity: auditsuzuki.ca	Entity: bernardtheroughneck.ca
Entity: leadersdebate.ca	Entity: auditsuzuki.ca	Entity: boycotfandee.com
Entity: letusreport.com	Entity: backstabbers.ca	Entity: calltoyourdogs.com
Entity: letusvote.ca	Entity: bananfifa.com	Entity: comeandtakehem.ca
Entity: margaretmccusag-boyd.ca	Entity: barbariansbook.com	Entity: ezraelavant.com
Entity: ndpags.ca	Entity: beefreesom.ca	Entity: fatalismist.com
Entity: nicolegoehring.com	Entity: bobwarner.ca	Entity: fightingforrural.com
Entity: oneclarier.com	Entity: bobwarner.com	Entity: freebob.ca
Entity: ottawamurders.com	Entity: bombardierpayusback.com	Entity: fremitchell.ca
Entity: protectourkids.ca	Entity: boycottearfa.ca	Entity: frenatasha.com

Coordinated deepfakes



The top screenshot shows Google search results for "weresorryindia.com". The top result is "We're Sorry India - The Rebel" with a snippet: "We're sorry India - please don't think all Canadians are like Justin Trudeau and his family and friends. We're not. For example, thousands of Canadians voted..."

The bottom screenshot shows the website's content. The headline reads: "We're sorry India - Justin Trudeau is an embarrassment". Below the headline, it says "EZRA LEVANT" and "READ THE FULL STORY". There is a red button that says "JOIN THE PETITION NOW".



The screenshot shows the website for the Journal of Future Conflict. It includes the Queen's University logo, a search bar, and a navigation menu. The "RESEARCH" section lists several articles, including "Clinical Program Research Labs", "Cognitive Neuroscience Research Labs", "Developmental Research Labs", "Social Personality Research Labs", and "Journal of Future Conflict".

Below the research section, there is a section for "Journal of Future Conflict - Online Journal" and "Issue 02 (Fall 2020): CD&E, doctrine and lesson learned in support of future interstate conflict". This section lists several articles, including "David Kilcullen: Liminal Manoeuvre and Conceptual Envelopment: Russian and Chinese Non-Conventional Responses to Western Military Dominance since 1991 (PDF, 398 KB)", "Emily Spencer: Targeting: Beyond the Current Narrative: Reframing Inter-state Competition for the 21st Century (PDF, 376 KB)", "Karin Kanja Galeano, LTC Rick Galeano, Esther Mead, Billy Spann, Joseph Keady, and Nalin Agarwal: The Role of YouTube during the 2019 Canadian Federal Election: A Multi-Method Analysis of Online Discourse and Information Actors (PDF, 8.7 MB)", "August Cole and P.W. Singer: Thinking: The Unthinkable With Useful Fiction (PDF, 383 KB)", and "Suzanne Waldman and Major Marshall Erickson: Strategic Communication in the Present and Future Military Enterprise (PDF, 392 KB)".

At the bottom, there is a section for "Colonel (Retired) Bernd Horn: The End of The Golden Age Of SDF? Is There a Role for Special Operations Forces in the Renewed 'Great Power Competition'? (PDF, 569 KB)".

For further information please contact the editor of the Journal of Future Conflict, Anthony Seaboyer at anthony.seaboyer@rmc.ca.



The Canadian Special Operations Forces Command (CANSOFCOM)

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Preprints (earlier versions) of this paper are available at <https://preprints.jmir.org/preprint/26933>, first published January 04, 2021.

Bots and Misinformation Spread on Social Media: Implications for COVID-19

McKenzie Himelein-Wachowiak ¹ ; Salvatore Giorgi ^{1,2} ; Amanda Devoto ¹ ; Muhammad Rahman ¹ ; Lyle Ungar ² ; H Andrew Schwartz ³ ; David H Epstein ¹ ; Lorenzo Leggio ¹ ; Brenda Curtis ¹ 

Article	Authors	Cited by (1)	Tweetations (10)	Metrics
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Abstract

As of March 2021, the SARS-CoV-2 virus has been responsible for over 115 million cases of COVID-19 worldwide, resulting in over 2.5 million deaths. As the virus spread exponentially, so did its media coverage, resulting in a proliferation of conflicting information on social media platforms—a so-called “infodemic.” In this viewpoint, we survey past literature investigating the role of automated accounts, or “bots,” in spreading such misinformation, drawing connections to the COVID-19 pandemic. We also review strategies used by bots to spread (mis)information and examine the potential origins of bots. We conclude by conducting and presenting a secondary analysis of data sets of known bots in which we find that up to 66% of bots are discussing COVID-19. The proliferation of COVID-19 (mis)information by bots, coupled with human susceptibility to believing and sharing misinformation, may well impact the course of the pandemic.

J Med Internet Res 2021;23(5):e26933

doi:10.2196/26933

29 Jul 2020 | 19:00 GMT

Twitter Bots Are Spreading Massive Amounts of COVID-19 Misinformation

About 25 percent of links to “low credibility” sources of coronavirus information come from bots

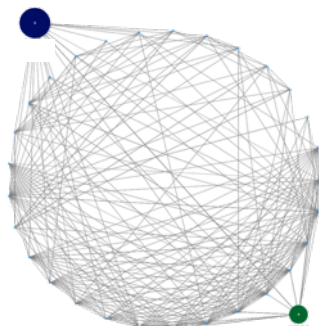
By Thor Benson



Sharing content and links to low credibility sources. Operating in a coordinated manner.

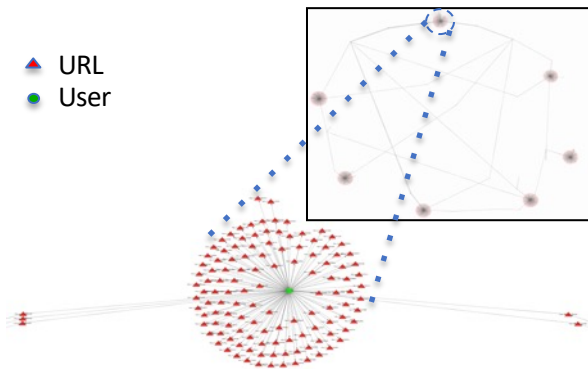
From bots → botnets → social bots

Published by NATO StratCom COE

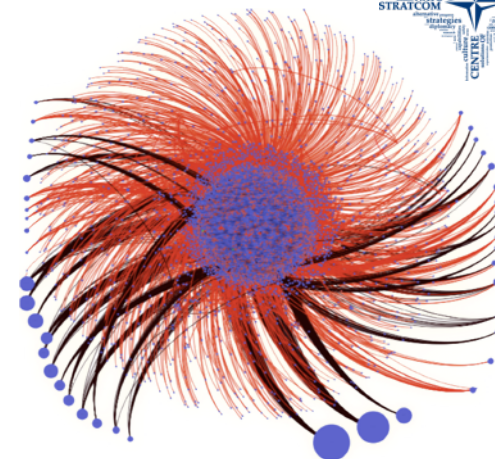


Mutual reciprocity.
IFYFM & FMIFY

▲ URL
● User



No mutual reciprocity.
Coordination in information network



Organizational hierarchy.
Core and peripheral bots

COORDINATION/BEHAVIOR COMPLEXITY



Crimean Invasion 2014



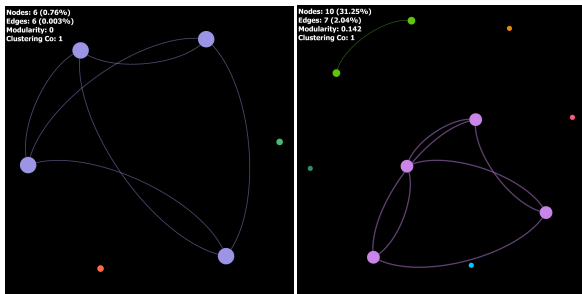
Dragoon Ride 2015



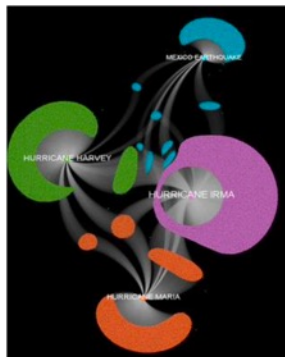
Trident Juncture 2015



ISIS Propaganda 2016

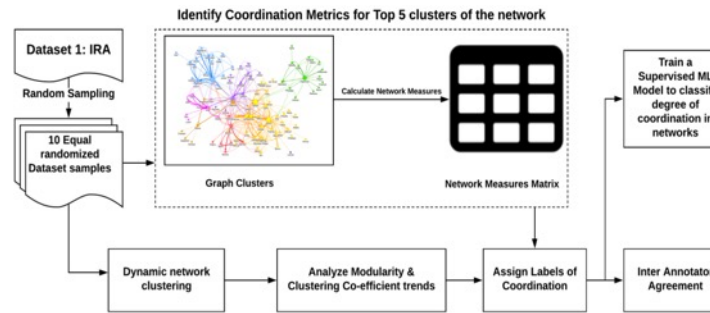


IRA Twitter bot data released by US Intelligence Agencies

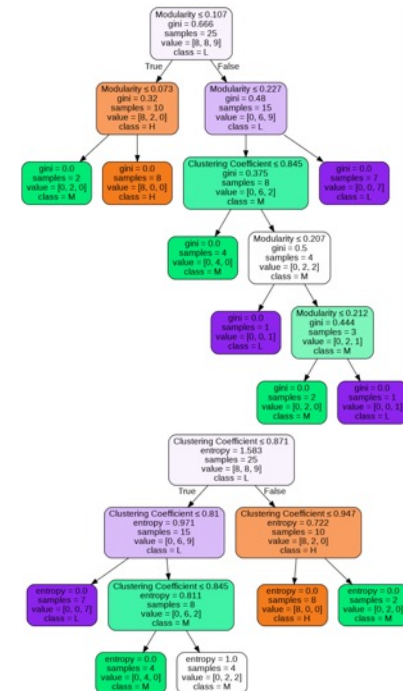
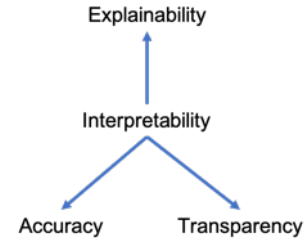
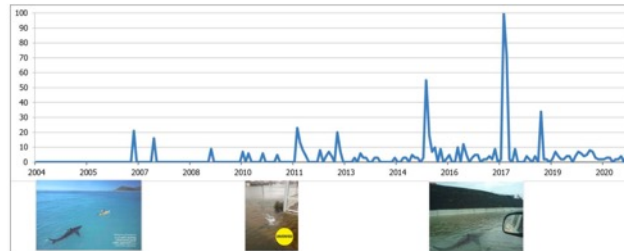


Language	Hashtag (Translation)
English	#DACA, #BlackLivesMatter
Spanish	#VenezuelaDemocraciaYDiálogo (Venezuela Democracy and Dialogue), #Cáncer (Cancer)
Arabic	(The demise Of Israel) #الارسلان (The Jews)
French	#Nuclear (Nuclear), #GendamerieEnOperation (Gendamerie Special Operations)
Mandarin	金正恩 (Kim Jong-un), 核试验 (Nuclear Test)

Detecting coordination among Twitter social bots (Khaund & Agarwal, 2020) SBP-BRiMS



Bot coordinated misinformation during Hurricanes



Computational propaganda tactics on YouTube detected using a groundbreaking multimedia processing approach based on color theory.
Research received Best Paper award at the International Conference on Human and Social Analytics (HUSO), Oct.18-22,2020

Video ID: OM5vaF2kzPA
Title: China vs US The War in the South China Sea already Start
Channel: Breaking News TV



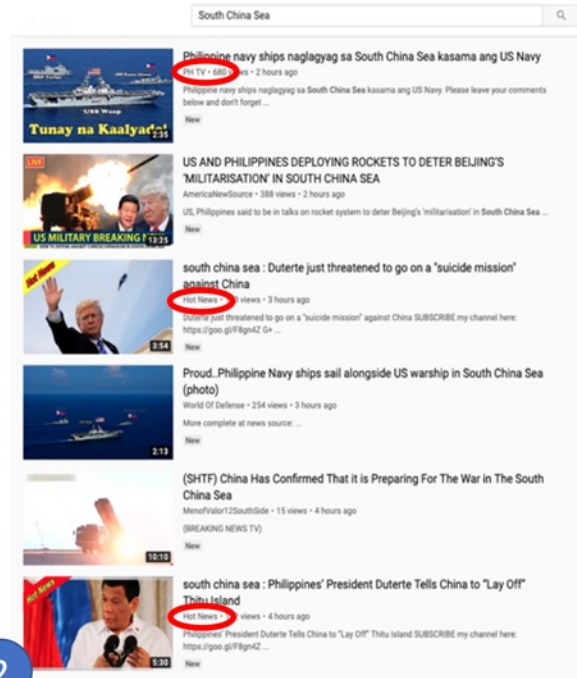
Video ID: GsCmudyXY2o
Title: China vs US The War in the South China Sea already Start
Channel: DOT COM US



Similar videos detected on different YouTube channels using barcode approach. Below, network of channels identified deploying crowd amplification tactic.



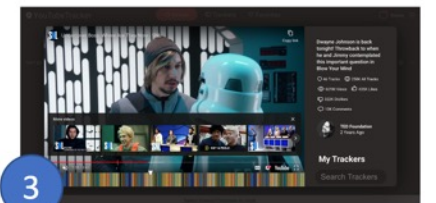
Crowd amplification tactic successfully manipulated YouTube's search results. "Hot News" - a prominent channel disseminating anti-US videos related "South China Sea" conflict – shows up at top of the search results.



Video barcode technique has been transitioned to YouTubeTracker



Video barcode technique allows us to navigate interesting narrative elements for a collection of videos pertaining to an event (above) or a single video (below)



Virality over veracity!

How to observe, identify, and measure algorithmic bias?

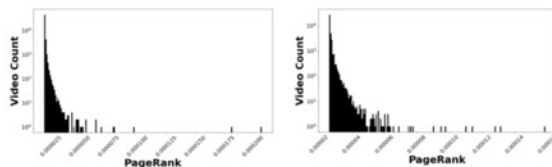


Fig. 1. Distribution of PageRank values in the recommendation graphs 1 (left) and 2 (right). We observe similar results in all recommendation graphs. The count of videos is represented in log scale on the y-axis.

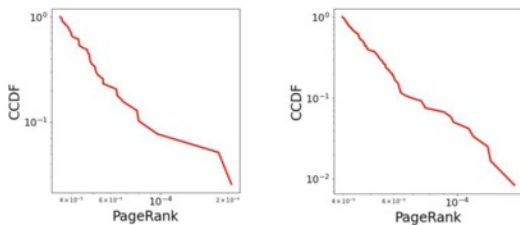
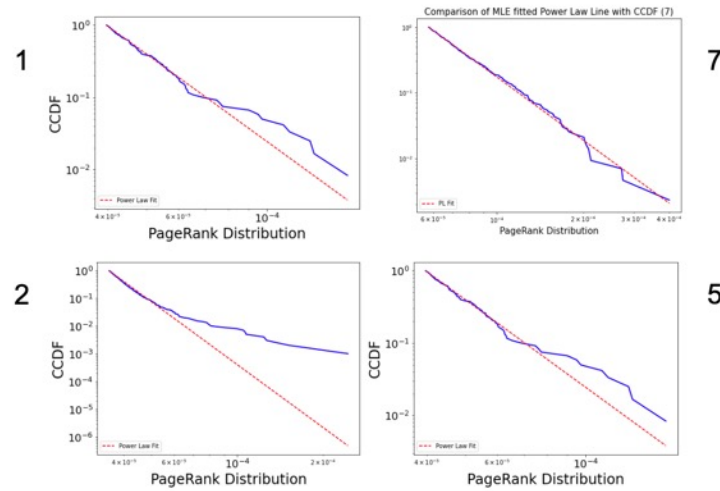


Fig. 2. Complementary Cumulative Distribution Function (CCDF) Plots of PageRank Scores in each Recommendation Graphs 1(left) and 2 (right).

Topic drift and decrease in relevance was observed.

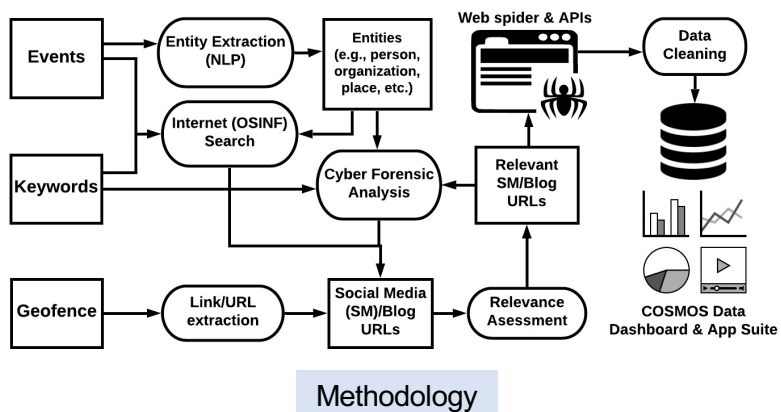


Top PageRank videos were removed weeks or months after their appearance in the recommendation network. Reason for content removal is violation of platform terms and services.

Kirdemir, B., Kready, J., Mead, E., Hussain, M., Agarwal, N., and Adjeroh, D. (2021) Assessing Bias in YouTube’s Video Recommendation Algorithm in a Cross-lingual and Cross-topical Context. Proceedings of the International Conference on *Social Computing, Behavioral-Cultural Modeling & Prediction, and Behavior Representation in Modeling and Simulation (SBP-BRiMS 2021)*, July 6-9, 2021, Washington D.C.

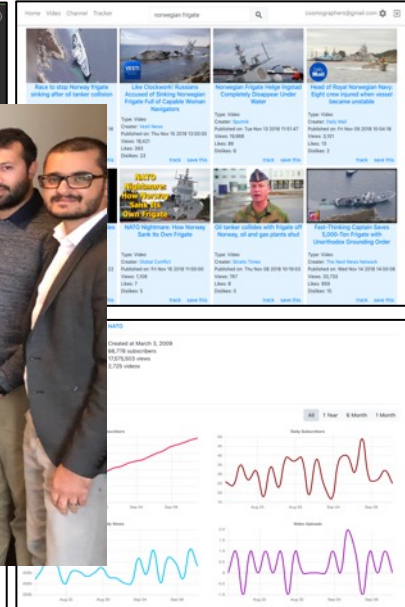
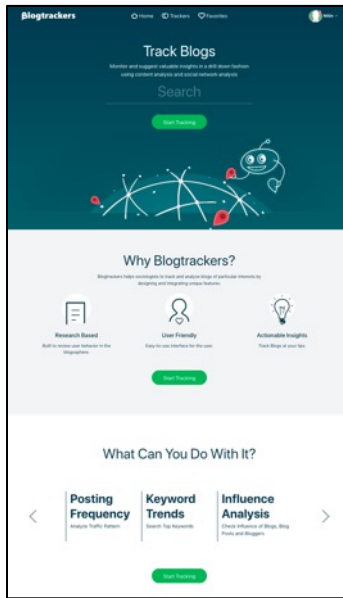
Over 150 GB of data every day consisting of text, images, audio, video, networks, and metadata

Multi-threaded, distributed, resilient, and scalable data collection framework has been developed, evaluated, and deployed.



- Anti-Vaccination discourse
- COVID-19 misinformation
- Indo-Pacific influence campaigns
- NATO's 2015 – 2019 Military Exercises (Trident Juncture, Brilliant Jump, Anakonda, Baltic Operations)
- Canadian 2019 Prime Ministerial Elections
- US 2016 Presidential Elections (e.g., IRA social bot data)
- Migrant crisis (European Union)
- Ukraine and Russia conflict (Euromaidan, Crimean annexation)
- Ukrainian political affairs
- Balkan political affairs
- Venezuelan socio-political crisis
- Blogs
 - 27 attributes
 - 14,854 blog sites, 3,243,408 posts, and 13,794,757 comments
- Twitter
 - 24 attributes
 - 281,546,290 tweets and 42,624,095 users
- YouTube
 - 60 attributes
 - 9,778 channels, 440,950 videos, 160,638,256 comments, 107,551,703 likes/dislikes/views, and 11,563,003 related videos
- Alternate platforms
 - BitChute, Parler, Rumble, Gab, etc.
 - 24 attributes
 - 2,723,790 posts and 38,490,624 views/likes

Browser
Plugin



Blogtrackers

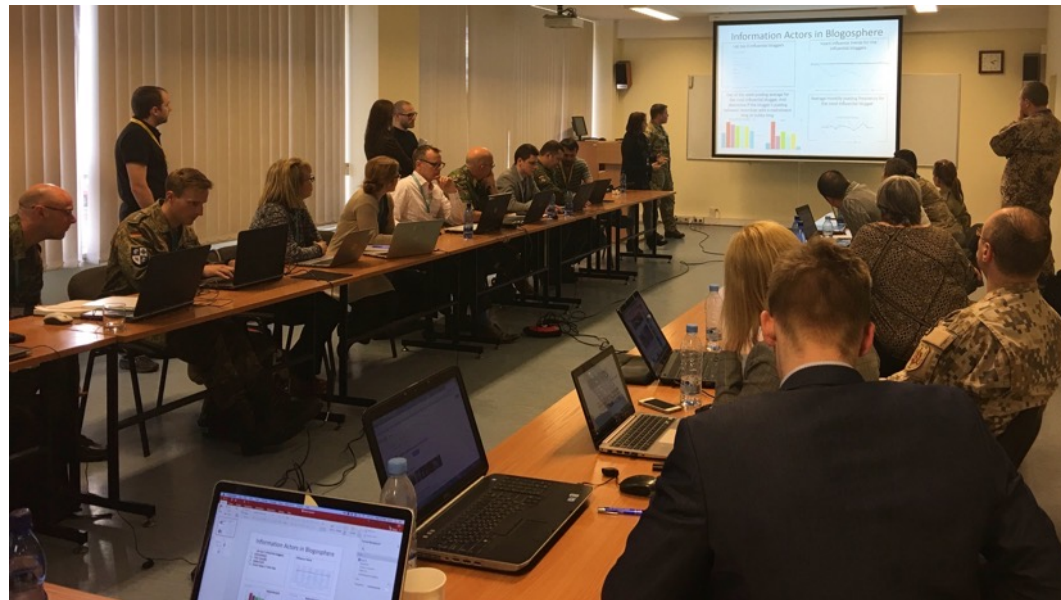
btracker.host.ualr.edu/

YouTubeTracker

vtracker.host.ualr.edu/

**Selected in US Department of State Global Engagement Center's
Tech Innovation program**

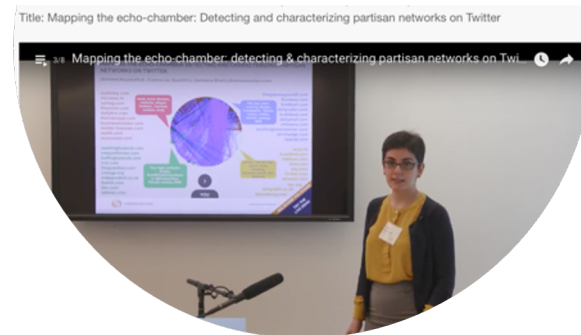
- III-Marines Expeditionary Force Information Group (III-MIG)
- NATO Strategic Communications Center of Excellence
- Marine Expeditionary Forces (2MEF)
- US CyberCommand's CyberSchool, Ft. McNair



- Supported by NSF Big Data program
- Over 50 member institutions worldwide including researchers, policy makers, journalists, cyber security professionals
- Outcomes of the working group include
 - Policy briefs laying out the research agenda
 - Collective catalog of resources to spark innovation among researchers



- Social Computing, Behavioral-Cultural Modeling and Prediction Conference, Washington D.C., July 6-9, 2021. (over 200 participants)



- Supported by several federal funding agencies.

- <http://sbp-brims.org/>



- Develop publicly available technologies and solutions
- Social media companies need to be more proactive, [Algotransparency.org](https://algotransparency.org)
- Emerging technologies like blockchain for content validation, decentralized social media platforms
- Build collaborative networks of practitioners, researchers, policy makers to address this problem together
- Strengthen media literacy programs
- Need to advance the dialog on cyber diplomacy

Nitin Agarwal, nxagarwal@ualr.edu

COSMOS Tools Developed:

- **COVID-19** - <https://cosmos.ualr.edu/covid-19>
- **Blogtrackers** - <https://btracker.host.ualr.edu/>
- **YouTubeTracker** - <https://vtracker.host.ualr.edu/>
- **Focal Structure Analysis** - <http://fsa.host.ualr.edu/>

Blogtrackers

YouTubeTracker



<https://cosmos.ualr.edu/>

Follow **cosmographers** on



ACKNOWLEDGEMENTS

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