Fighting Fire with Fire

Mitigating AI-enhanced Cognitive Threats

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COSMOS – Mission

- Vanguard in the field of Social Computing & Socio-Cognitive Threat Mitigation
- Develop tools to understand digital behaviors and forecast trends to achieve social good
- Develop and establish partnerships (university-industry-government), alliances, standards, and policies
- Promote and disseminate research, training, and education
- Work with US government agencies and allies to protect our nation from adversaries
- Accelerate industry adoption and incubate commercialization opportunities

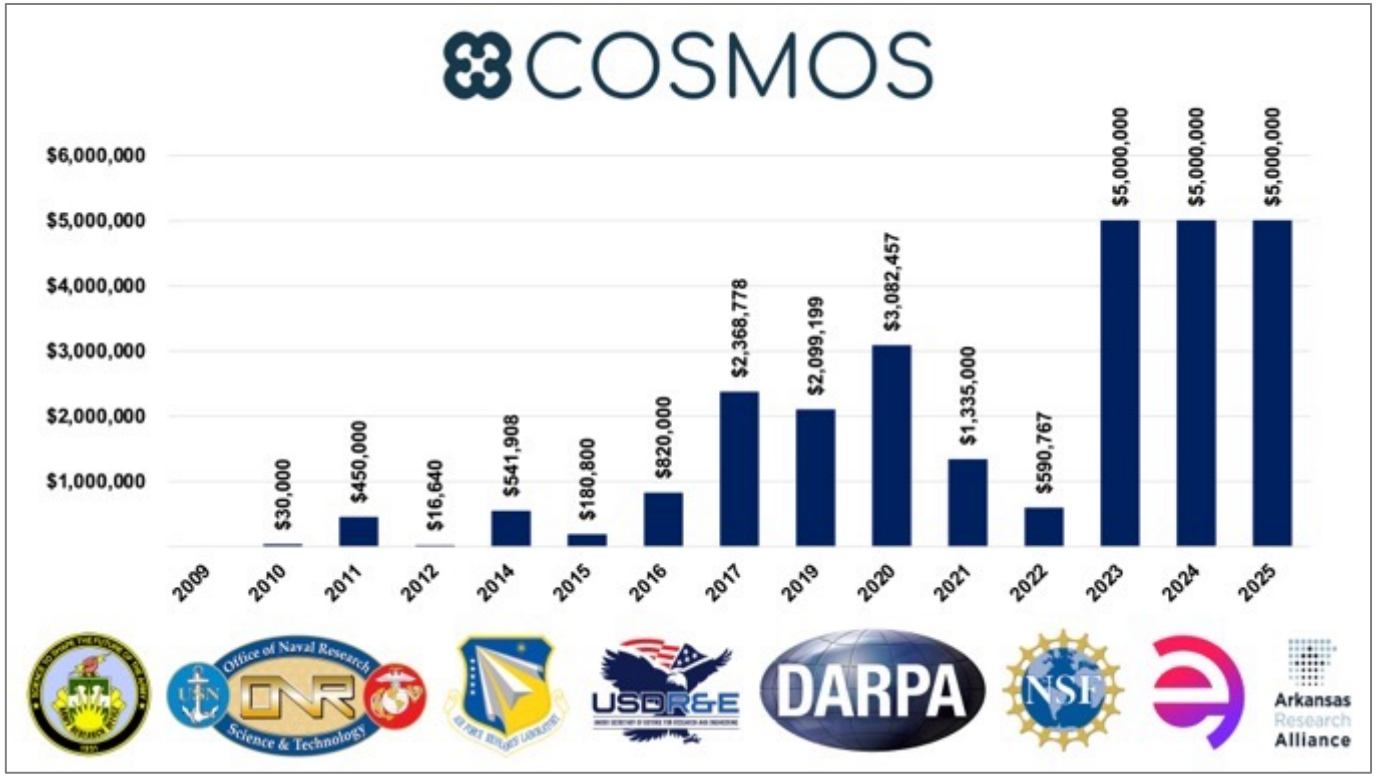
NATO & WHO recognized COSMOS tools

Collaborators

Research Thrusts

- Mitigating cognitive threats & enhancing community resiliency
- Combating AI-generated and amplified influence campaigns
- Toxicity, polarization, terrorism
- Social movements and collective action
- Smart and connected health

37 grants as PI (total $69 million and $30 million to UALR/COSMOS)



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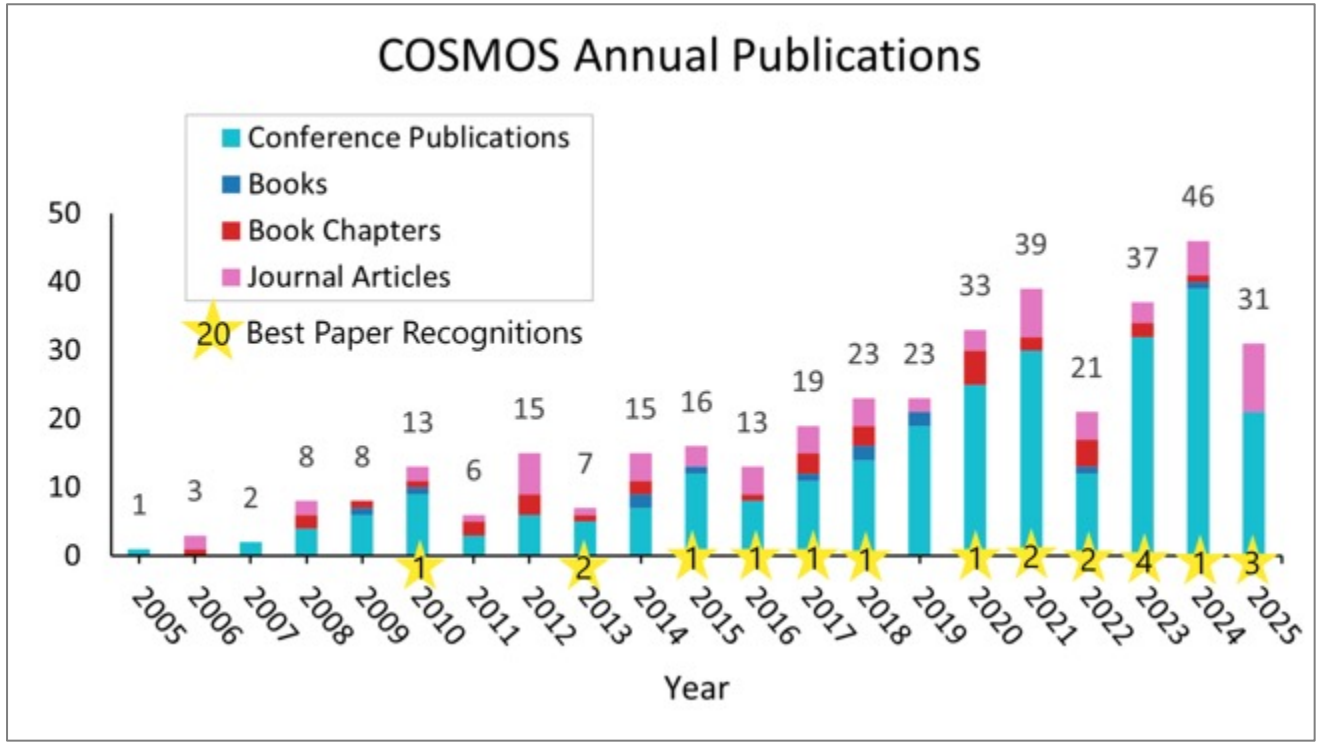

COSMOS

Collaboratorium for Social Media and Online Behavioral Studies

Statewide research center headquartered in the University of Arkansas - Little Rock, USA

100+ members (Canada, USA, St. Vincent & The Grenadines, Germany, France, Turkey, Nigeria, Iraq, Pakistan, India, Nepal, Bangladesh)

Funding $30 million from US Army, Navy, Air Force, DARPA, NSF.

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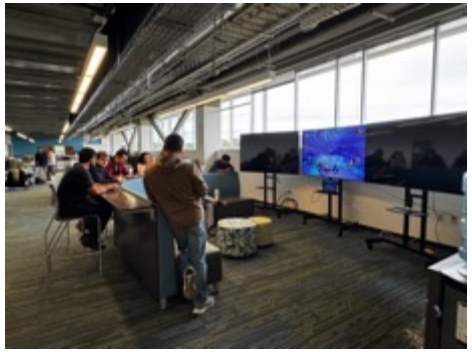
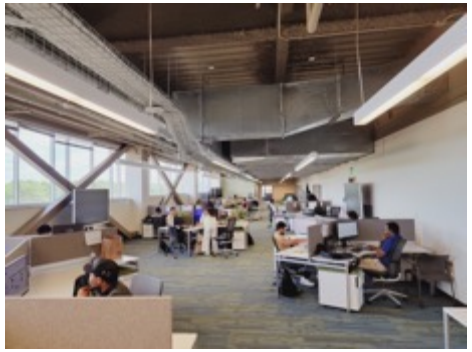
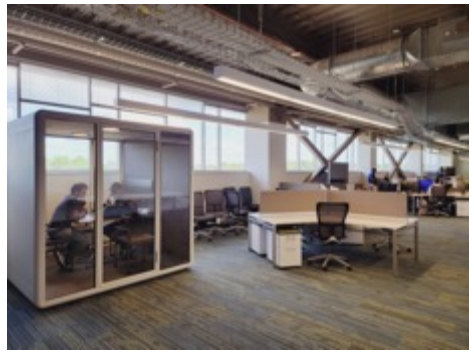
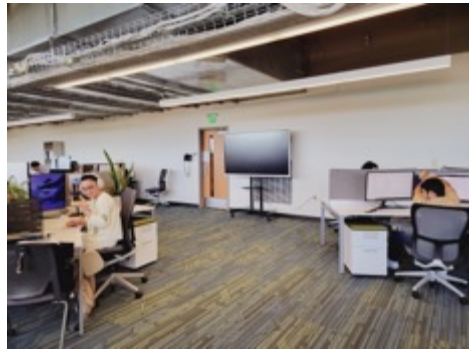
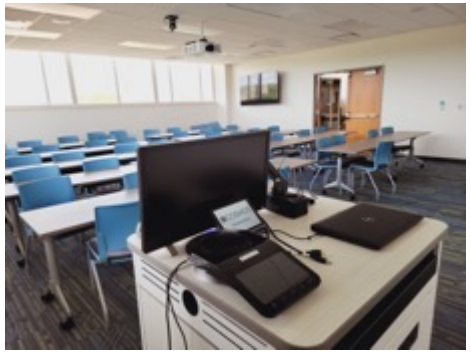
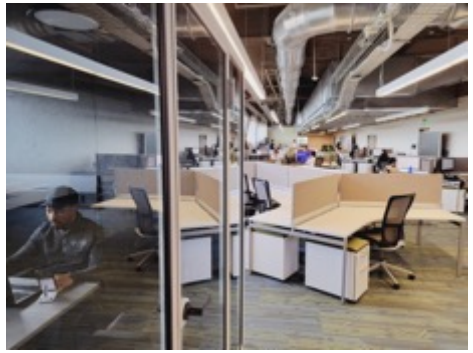
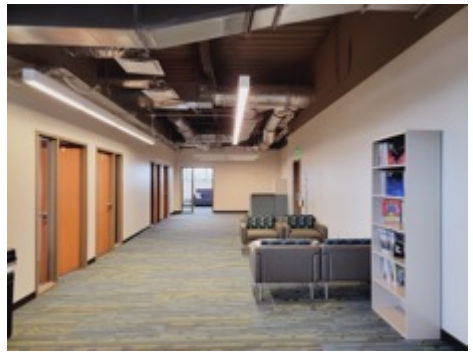
COSMOS


New space for COSMOS!
EIT 603

Mitigating Cognitive Threats

- **Cognitive is categorized as the 6th and newest warfighting domain after land, sea, air, space, and cyber**

- **Influence operations**: Anti-US and allies (e.g., NATO, EU)

Dragoon Ride 2015

Trident Juncture 2015

Brilliant Jump 2016

Anakonda 2016

Trident Juncture 2018

Baltic Operations 2019

ISIS flag misusing the *kalma*

- **Social media channels** for US Air Force Public Affairs Office
- **Terrorist** groups campaigns for recruitment, radicalization, and raising funds.
- **Indo-Pacific region** (Australia, Indonesia, Malaysia, Philippines, Singapore, Taiwan)
- **Pandemic**: COVID-19 scam busting & awareness (Arkansas AG, FVEYS, NATO)

Strengthening Community Resiliency

- Characterizing *multimedia information environment* tactics (TTPs) and impact assessment **[$5 million from US DOD - 2023]**
- Characterizing *coordinated cognitive attacks* through collective action-based framework **[$5 million from US DOD - 2024]**
- Characterizing information actors (producers and consumers) engaged in cognitive attacks **[$5 million from US DOD - 2025]**

ARO NATO

Developing Socio-computational Approaches to Mitigate Socio-cognitive Security Threats in a Multi-platform Multimedia-rich Information Environment

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ABSTRACT

Growing weaponization of social media is influencing peacekeeping, tactical, operational, and strategic operations. At the strategic and operational levels, social media platforms that are manipulated by adversarial campaigns can shift international and regional opinions about the use of military force or validity of military operations in a region. At the tactical level, social media propaganda could potentially be used to persuade susceptible targets to disrupt or delay military operations through protests or other "non-lethal" resistance. Narratives can be easily manipulated and influenced by bots, trolls, and other influence operation TTPs. Moreover, most users of social media cannot or will not differentiate between legitimate and non-legitimate accounts. Since such influence operation TTPs can be employed clandestinely in a low-cost, low-risk context, military leaders can expect to encounter an increased amount of adversary-generated AI-amplified social media-driven propaganda. Furthermore, socio-cognitive threats are increasingly becoming – (1) a collective phenomenon and (2) multimedia online information environment centric. This study aims to advance social, behavioural, and cultural science and enhance situation awareness and sensemaking (HFM ET-356 House Model) by detecting, examining, evaluating, measuring, and predicting the cognitive threat level/impact of the adversarial information campaigns to strengthen community resiliency further. The models and approaches presented in this study are validated and demonstrated in real-world use cases (e.g., COVID-19, the Indo-Pacific region). A multi-model multi-theoretic approach is developed that blends computational modelling, big 'social' data, and social science theoretical principles to characterize adversarial information campaigns conducted in an integrated online information environment (OIE). Specifically, the research identifies key actors, groups/mobs, narratives, TTPs (and their impact), in mainstream platforms as well as emerging and multimedia-rich platforms to characterize information actors (producers and consumers) and campaign dynamics for proactive decision-making to mitigate cognitive threats.

NATO ework.

NATO STO-MP-HFM-361 Symposium on Mitigating and Responding to Cognitive Warfare

Influence Assessment

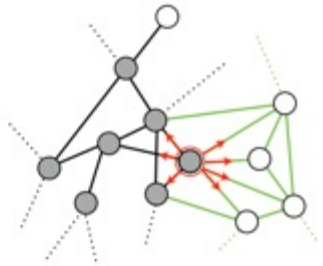
Real-time influence assessment

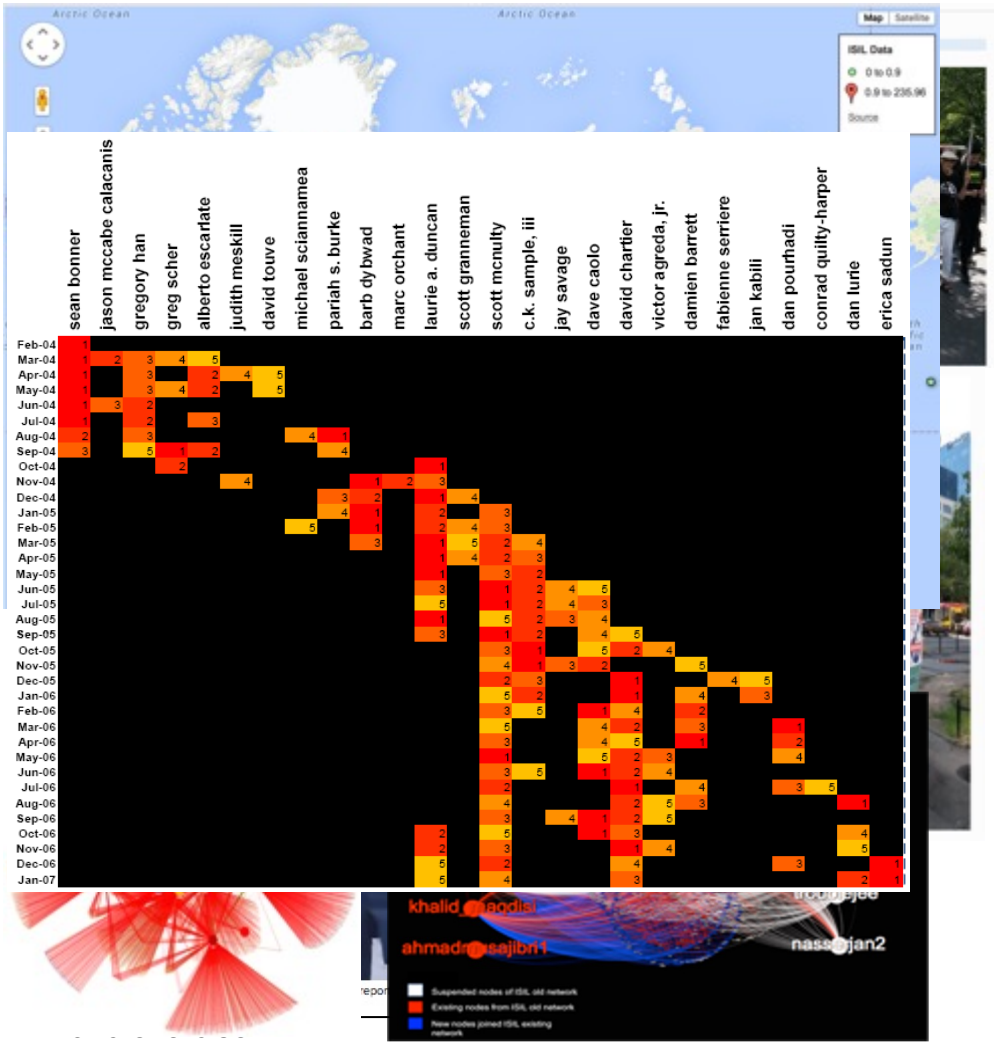
$$InfluenceFlow(p) = w_{in}\sum_{m=1}^{|I|} I(p_m) - w_{out}\sum_{n=1}^{|\theta|} I(p_n)$$

$$I(p) \propto w_{comm}\gamma_p + InfluenceFlow(p)$$

$$I(p) = w(\lambda) \times (w_{comm}\gamma_p + InfluenceFlow(p))$$

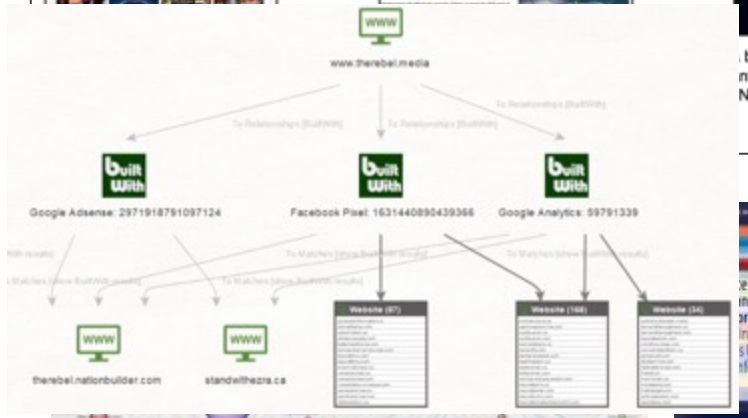
$$iIndex(B) = \max(I(p_l))$$

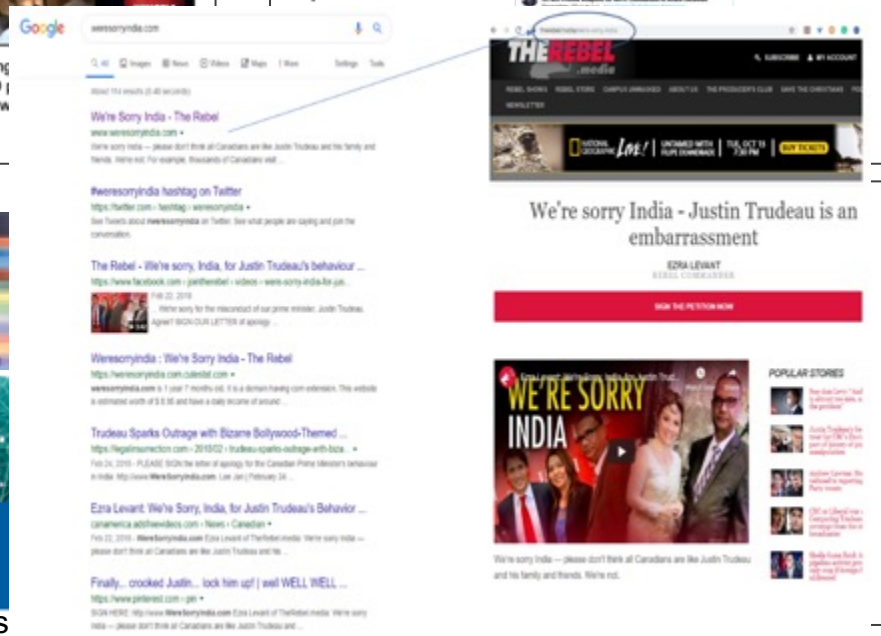




Multiplatform Influence Campaigns

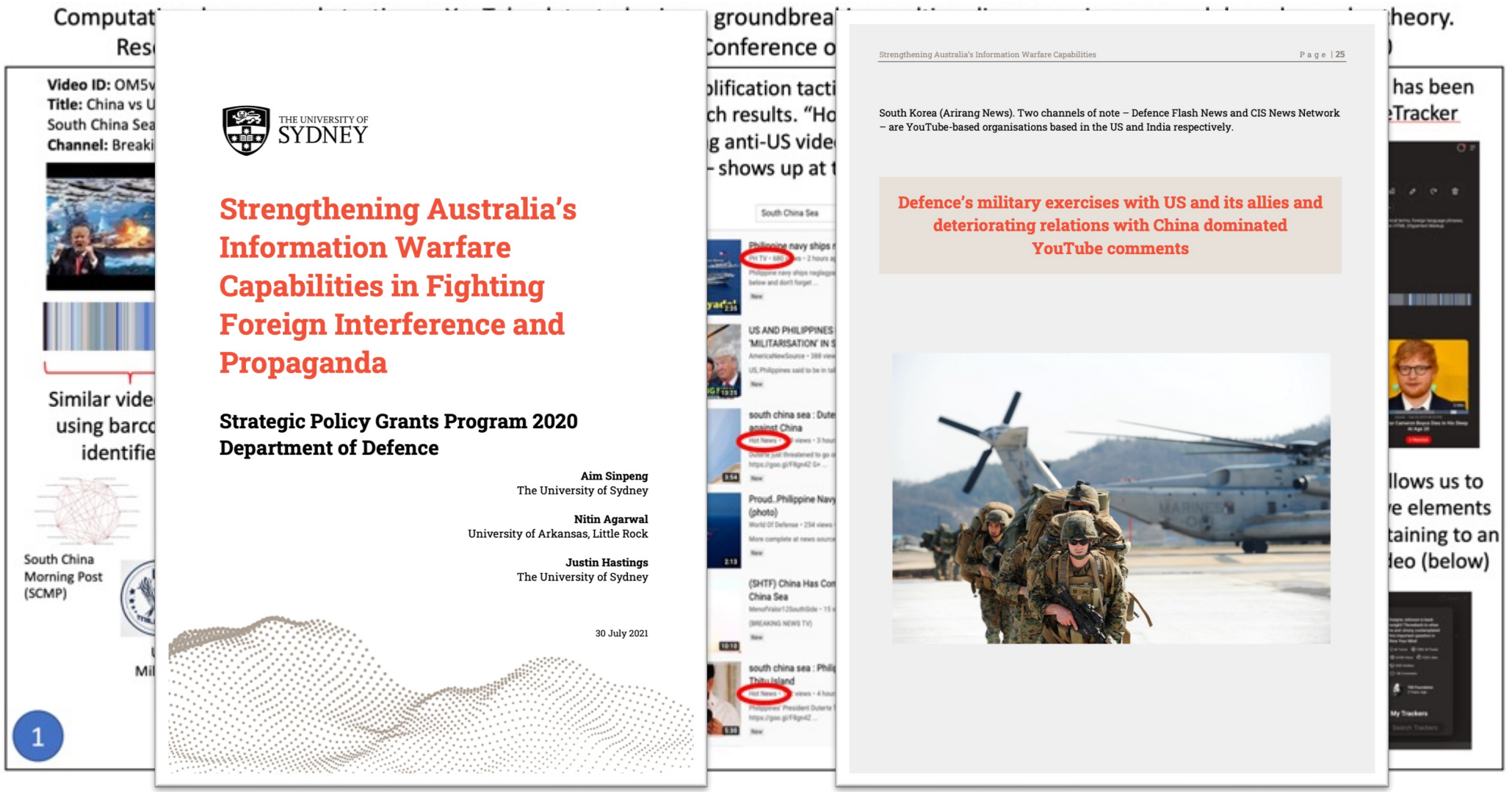
Influence Campaigns: Designated domains for controversial subjects to draw traffic to main site. Orchestrated use of Twitter hashtags and cross media campaigns to drive traffic to designated domains.





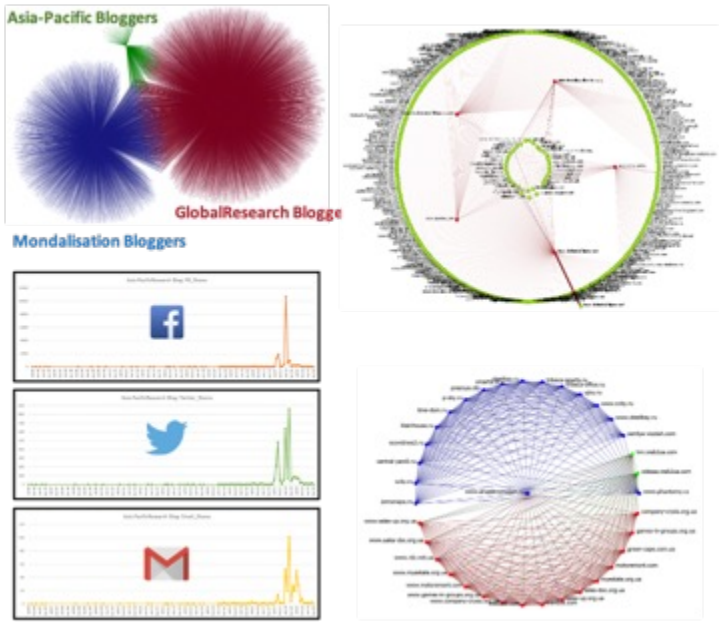
291 fake websites created using “Built with API” service with anti-Trudeau narrative. One such fake website “weresorryindia.com” amplifies anti-Trudeau narrative suggesting he is not a friend of the Canadian-Indian community. The website tops the results in search engines

Multimedia Influence Campaigns



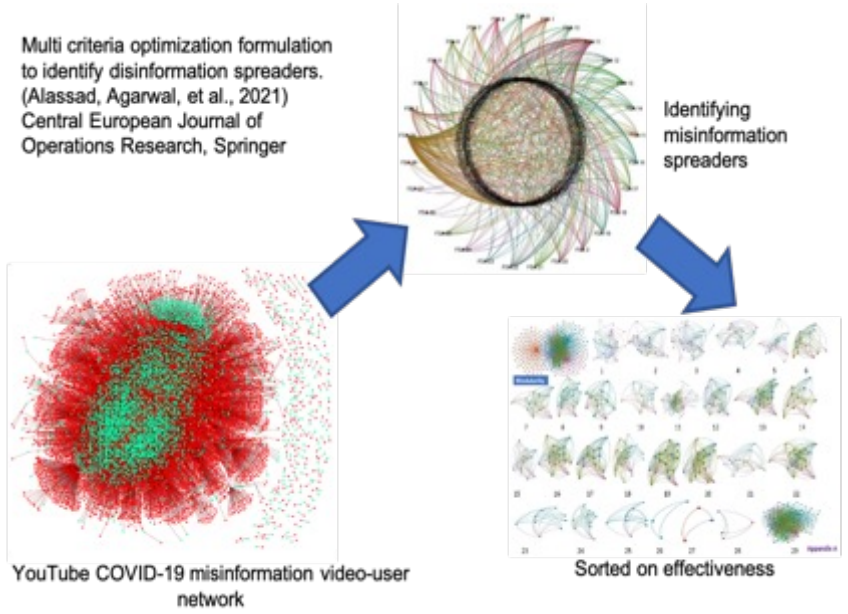
Coordinated Campaigns

Coordinated bloggers



Anti-West/anti-US Indo-Pacific bloggers

Coordinated YouTubers

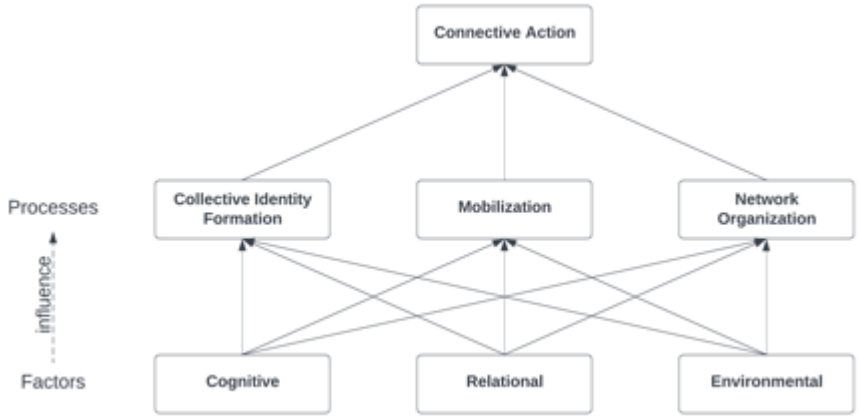


Anti-West/anti-US Indo-Pacific YouTubers

Coordinated Twitter users

Anti-West/anti-US Indo-Pacific Tweeters

Coordinated Campaigns



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

Subject to

$$\delta_i = \{d\vec{c}_1 \preccurlyeq d\vec{c}_2 \preccurlyeq d\vec{c}_3 \preccurlyeq \cdots \preccurlyeq d\vec{c}_i\} - \overrightarrow{dc_j^Q} \quad \forall i,j \quad (2)$$

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

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

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

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

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

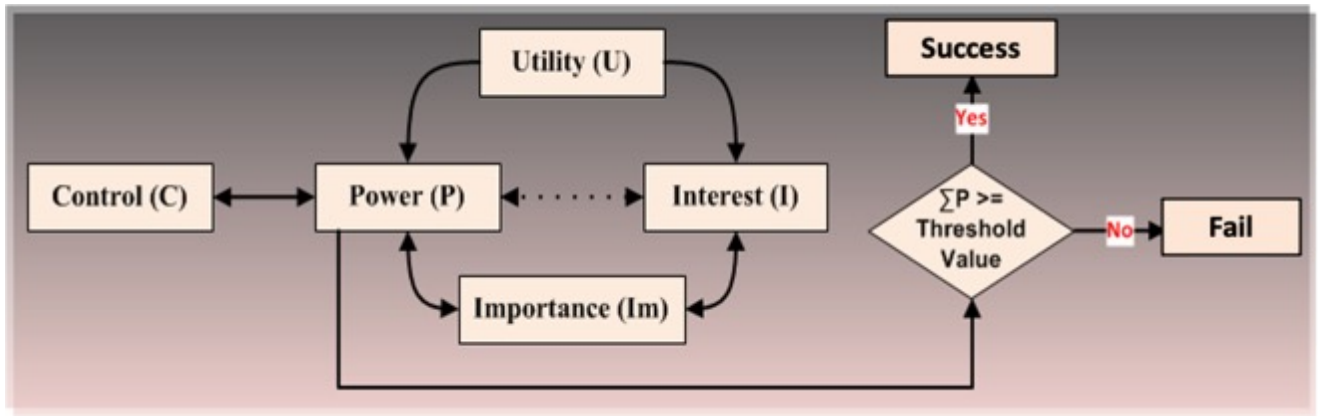
$$AC_G^k = \frac{1}{n}\sum_{i=1}^{n} a_i^c \quad (8)$$

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

$$\overrightarrow{C_p} = \{\vec{c_1}, \vec{c_2}, \vec{c_3}, \ldots, \vec{c_i}\} - \overrightarrow{c_j^Q} \quad \forall i,j \quad (10)$$

$$\overrightarrow{\partial \delta_{i,\kappa \times k}} = \overrightarrow{C_{\delta_i}} \quad \forall i \quad (11)$$

$$F = \left\{c_\emptyset, \overrightarrow{c_j^Q}, \overrightarrow{c_{j+1}^Q}, \ldots, \overrightarrow{c_\kappa^Q}\right\} \quad \forall j,\kappa \quad (12)$$



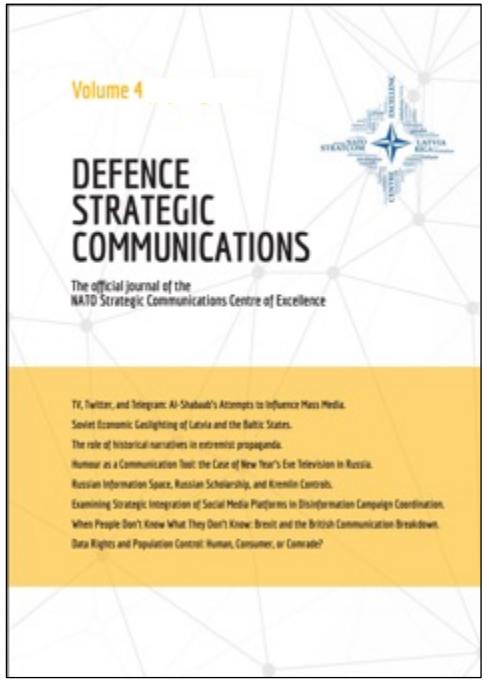
Communities	Political Category	No. of Users in Each Community	No. of Nodes	No. of Edges	Modularity	Average Weighted Degree	Average Betweenness Centrality	DCFM Power
Largest Community	Right	459	510	526	0.294	1.457	0	90.88
Second Community	Right	152	284	419	0.578	2.771	0	77.12
Third Community	Right	212	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

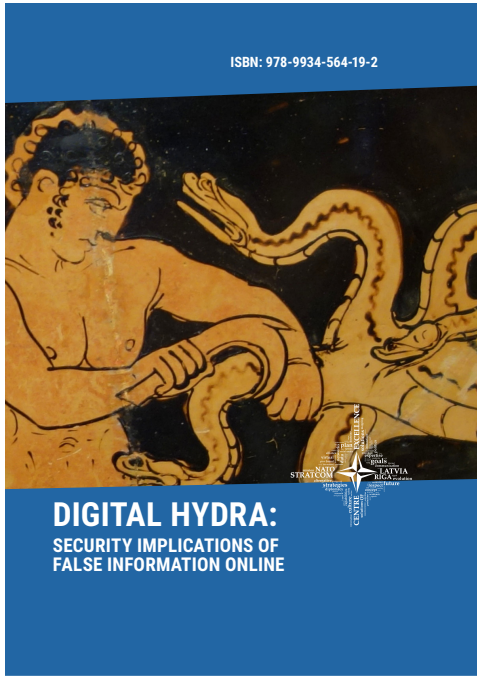
Elsevier Journal of Information Processing and Management. Springer's Central European Journal of Operations Research. Journal of Computational and Mathematical Organization Theory, Journal of Social Network Analysis and Mining. (2020, 2021, 2022, 2023, 2024, 2025)

Coordinated Campaigns

Published by Army University Press, in 7 volume book set on ***Large-Scale Combat Operations***, in the book titled "Perceptions are Reality: Information Operations" (AUSA)



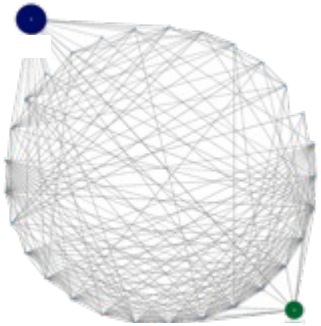
Examining Strategic Integration of Social Media Platforms in Disinformation Campaign Coordination. **Journal of NATO Defence Strategic Communications**



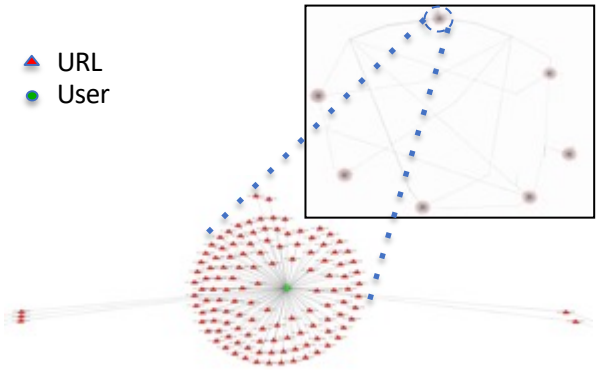
Blogs, Fake News, and Influence Operations. Digital Hydra: False Information Online as a Weapon, **NATO StratCom COE.**

Adversarial Human-AI Coordination

From bots → botnets → social bots

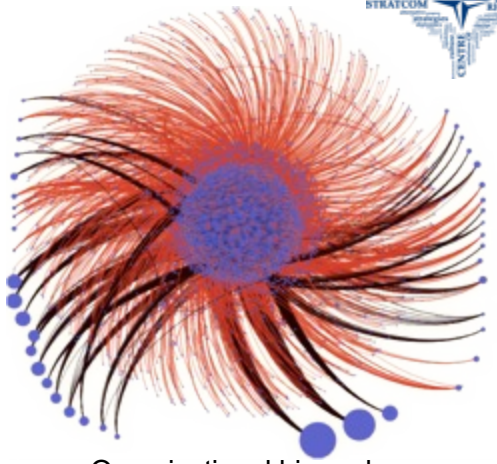


Mutual reciprocity.
IFYFM & FMIFY



No mutual reciprocity.
Coordination in information network

Published by NATO StratCom COE



Organizational hierarchy.
Core and peripheral bots

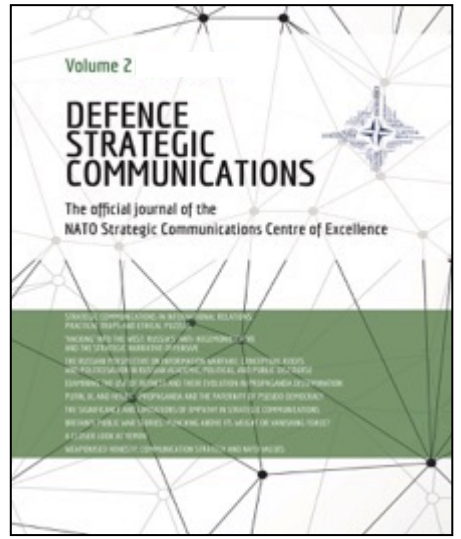
COORDINATION/BEHAVIOR COMPLEXITY

Crimean Invasion 2014

Dragoon Ride 2015

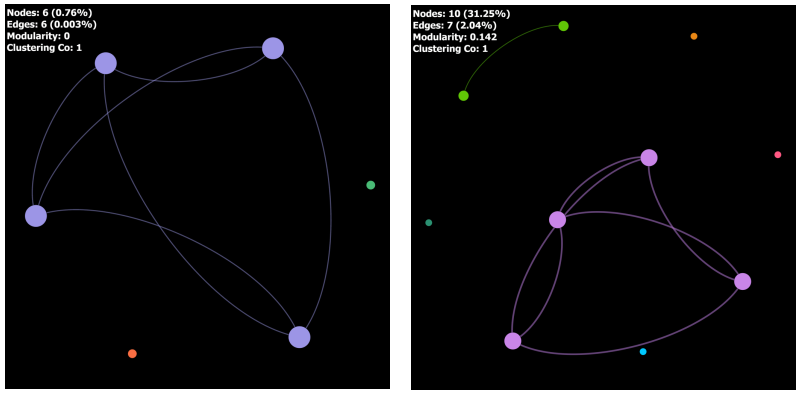
Trident Juncture 2015

ISIS Propaganda 2016



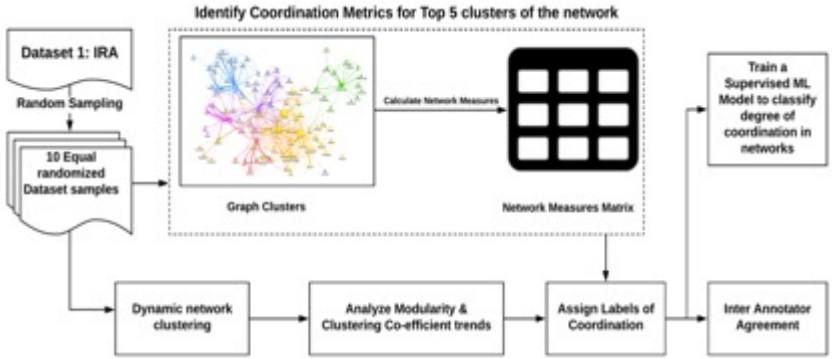
Examining the Use of Botnets and their Evolution in Propaganda Dissemination. **Journal of NATO Defence Strategic Communications**

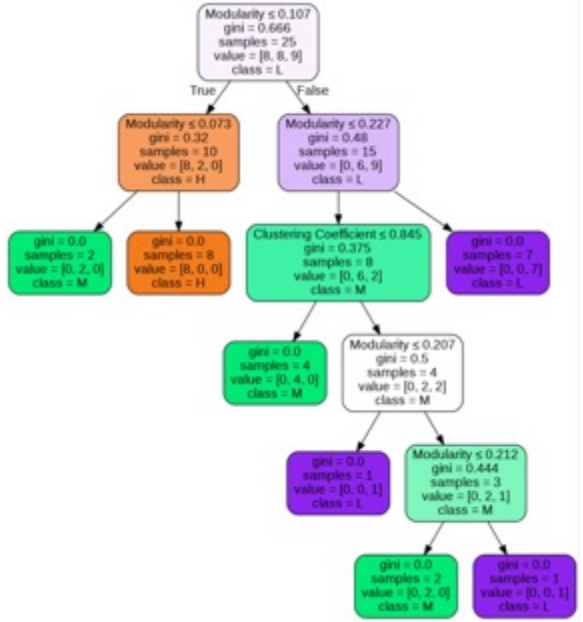
Modeling Botnet Coordination

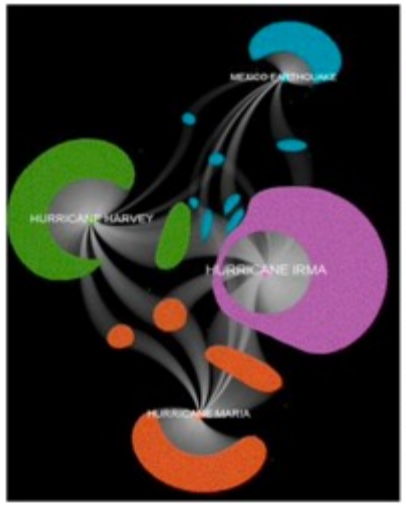


IRA Twitter bot data released by US Intelligence Agencies

Detecting coordination among Twitter social bots
IEEE Transactions on Computational Social Systems (TCSS), 2021, 2022, 2023, 2024, 2025.

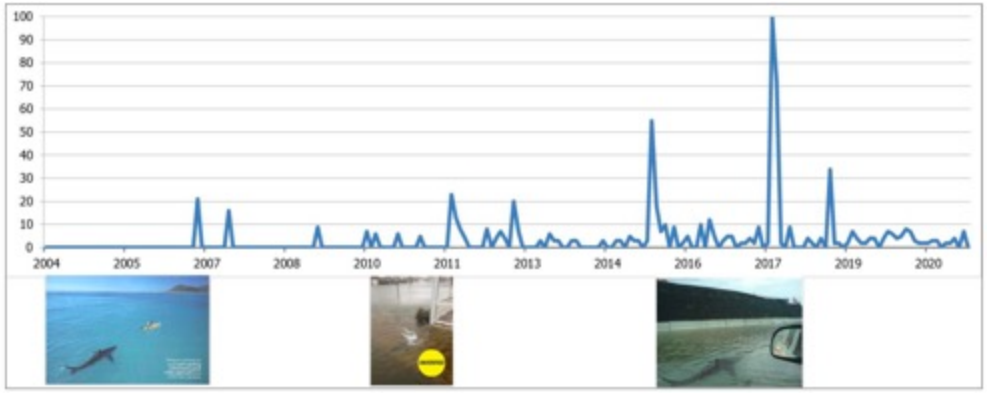


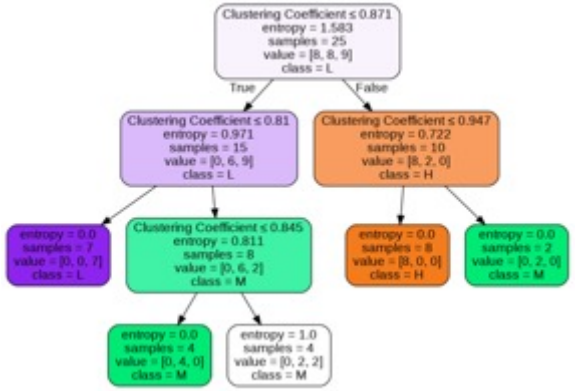




Language	Hashtag (Translation)
English	#DACA, #BlackLivesMatter
Spanish	#VenezuelaDemocraciaYDiálogo (Venezuela Democracy and Dialogue), #Cáncer (Cancer)
Arabic	(The demise Of Israel) #زوال_اسرائيل, (The Jews) #اليهود
French	#Nucléaire (Nuclear), #GendarmerieEnOpération (Gendarmerie Special Operations)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

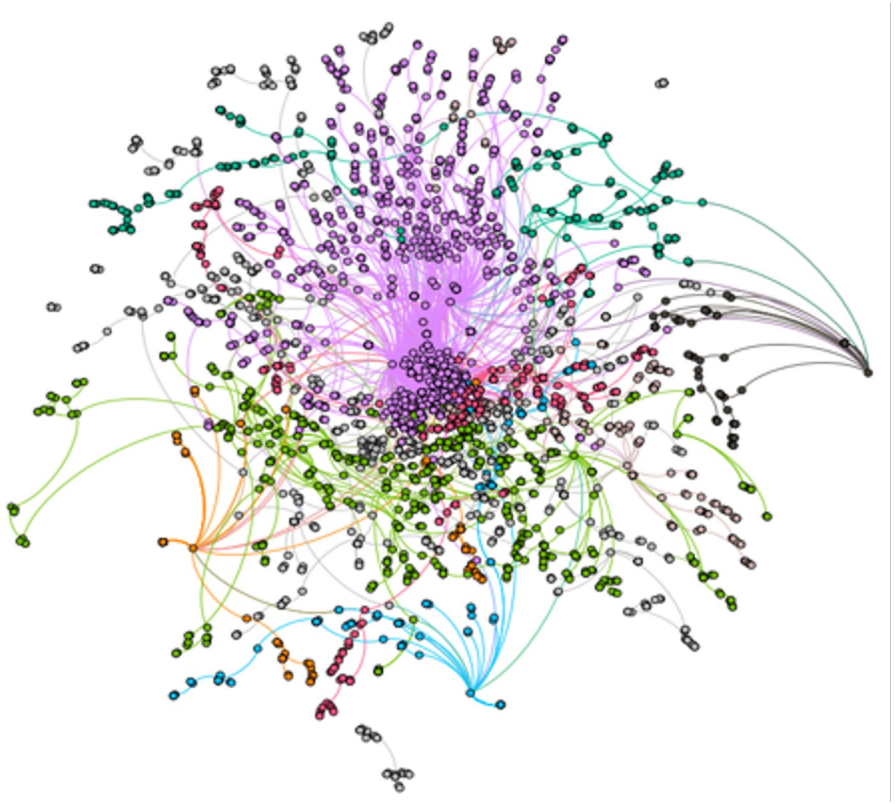
Bot coordinated misinformation during Hurricanes

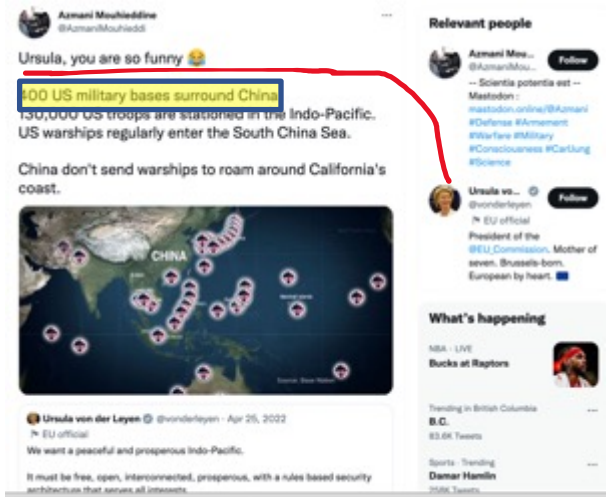




Example Botnet in Indo-Pacific

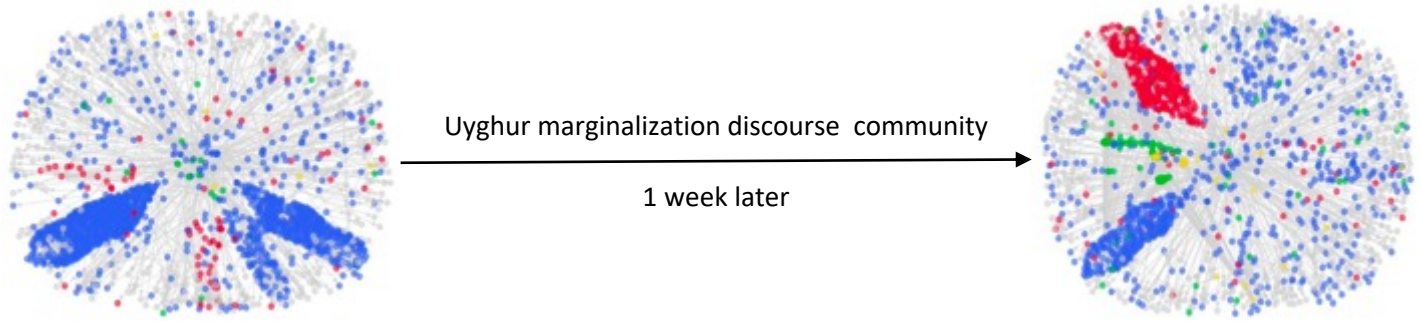
- Suspicious botnet from Indo-Pacific (US is the aggressor)

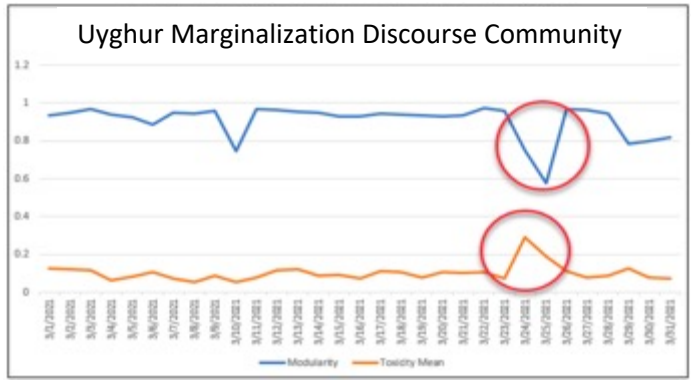


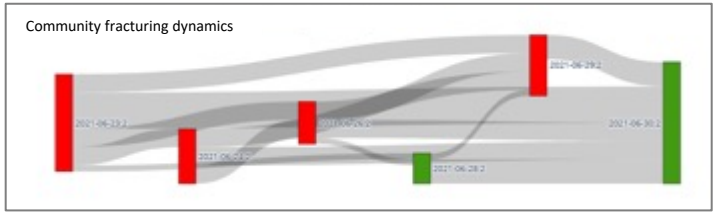


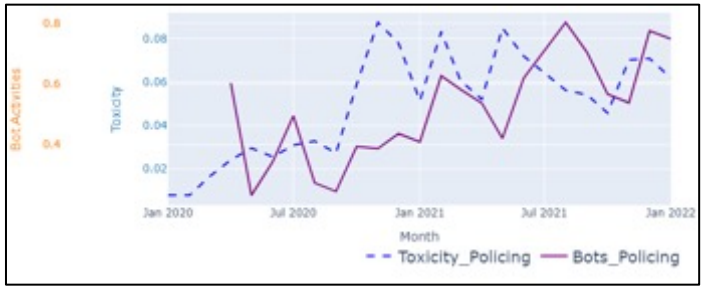
AI/Bots, Toxicity, & Community Dynamics

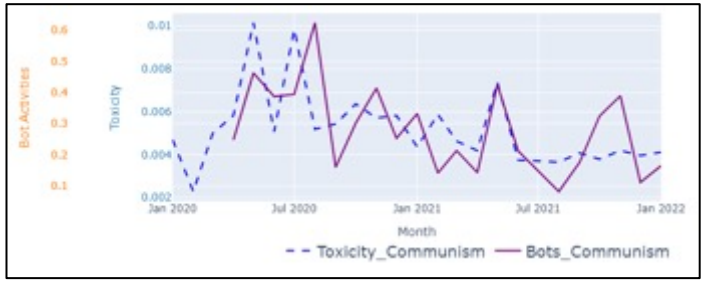
- Bot activity found to be positively correlated with toxicity.
- Toxic discourse causes disruption and polarization among communities.
- Community/discourse fractures when toxicity rises.
- Granger causality test suggests the effect is strongest after two days.
- This work shows a way to measure impact of bots.



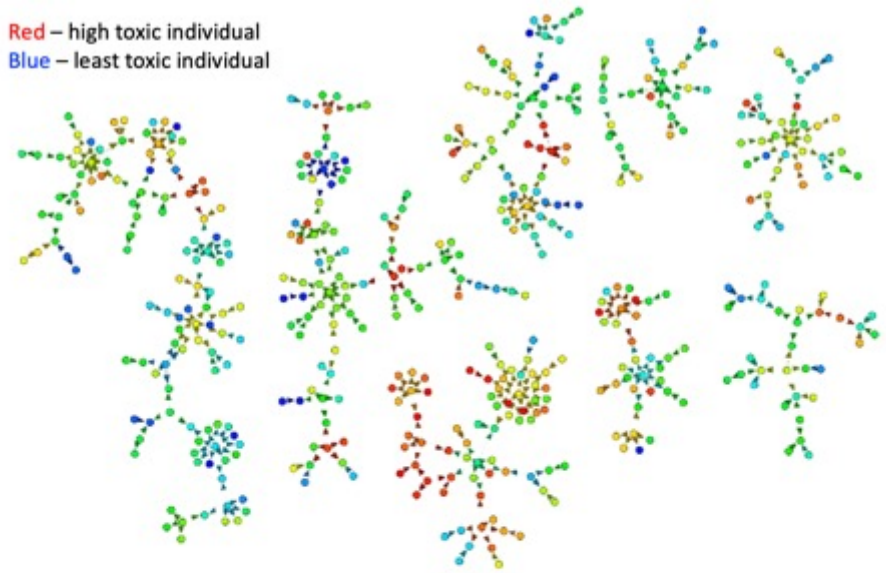








Networks and Toxicity



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.

STRS epidemiological model for toxicity propagation – Susceptible (S); Toxic (T); Recovered (R); Susceptible (S)

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.

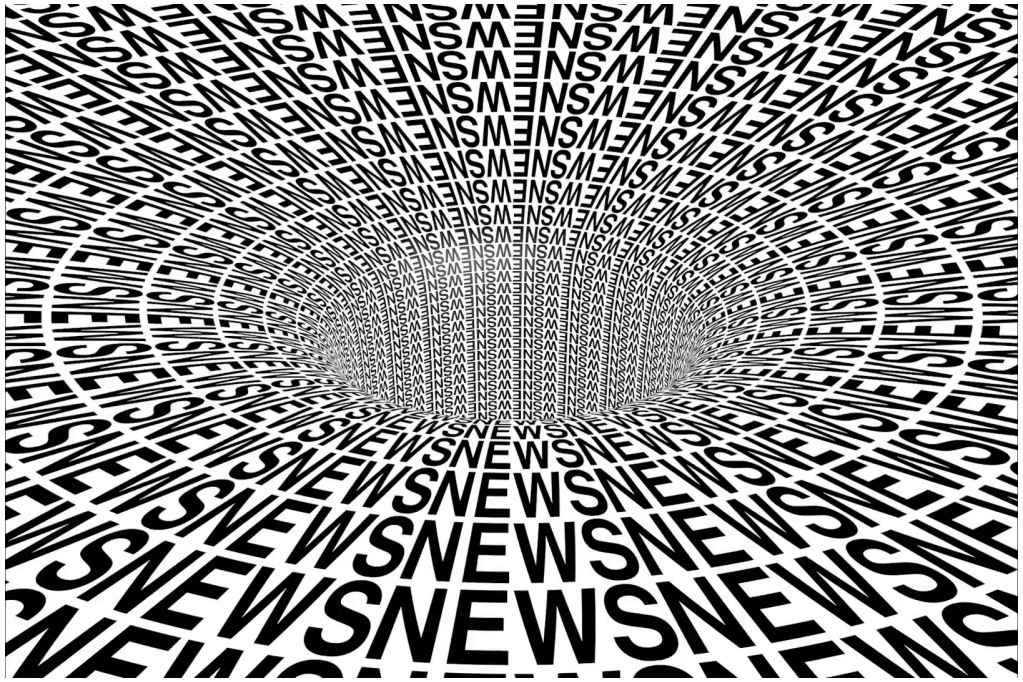
Experimental simulation	Toxicity score	Percentage reduction
Removal of top 10 users with high Betweenness centrality	0.720981759	0.21
Removal of top 10 users with high PageRank centrality	0.722317191	0.02
Removal of users with toxicity scores greater than 0.8	0.641927323	11.15

Elsevier Journal on *Information Processing and Management 2022*, HICSS 2022, AMCIS 2024, ICWSM 2024, 2025.

Working with Social Media platforms and Arkansas Office of the Attorney General

Platform AI ‘Recommender’ Bias

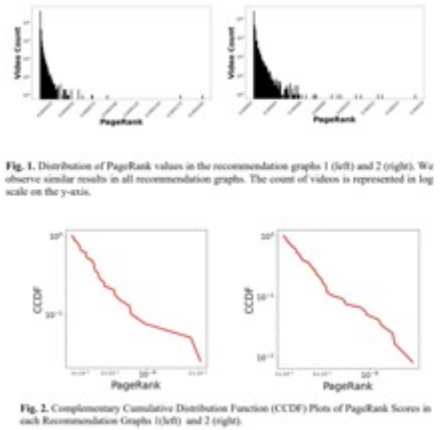
- AI-based recommendation algorithms that predict our shopping behaviors, books and articles to read, videos to watch lack transparency.
- Recommendation algorithm learns from behavioral data and perpetuates the underlying bias in its recommendations.
  - YouTube’s recommendation algorithm is known to push its viewers down the conspiratorial rabbit hole by suggesting related videos.
  - On Facebook, ads to recruit delivery drivers for Domino’s Pizza Inc. were disproportionately shown to men, while women were more likely to receive notices in recruiting shoppers for grocery-delivery service Instacart Inc.
- Explainable model could help in identifying causes of biased recommendations thereby enhancing the model's transparency.



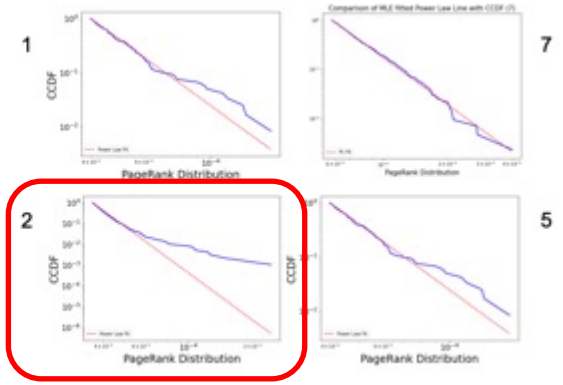
Characterizing AI Bias and Impact Assessment

- Channel characterization based on implicit algorithmic bias requires identification and measurement of bias.
  - Power law distribution fitting (exponent)
  - Gini coefficient - a single number that demonstrates a degree of inequality in a distribution of income/wealth.
- Characterization based on <u>context</u> -> Uyghur context showed largest implicit algorithmic bias, marked in red.
- Characterization based on <u>impact</u> -> Implicit bias resulted in information bubbles.

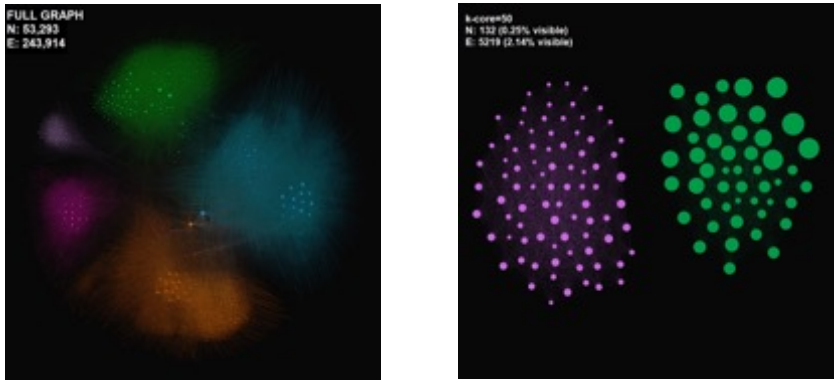
Complex Networks 2021; ECIR 2023; Complex Networks 2023, 2024; ASONAM 2023, 2024, HICSS 2025



Topic drift and decrease in relevance was observed.

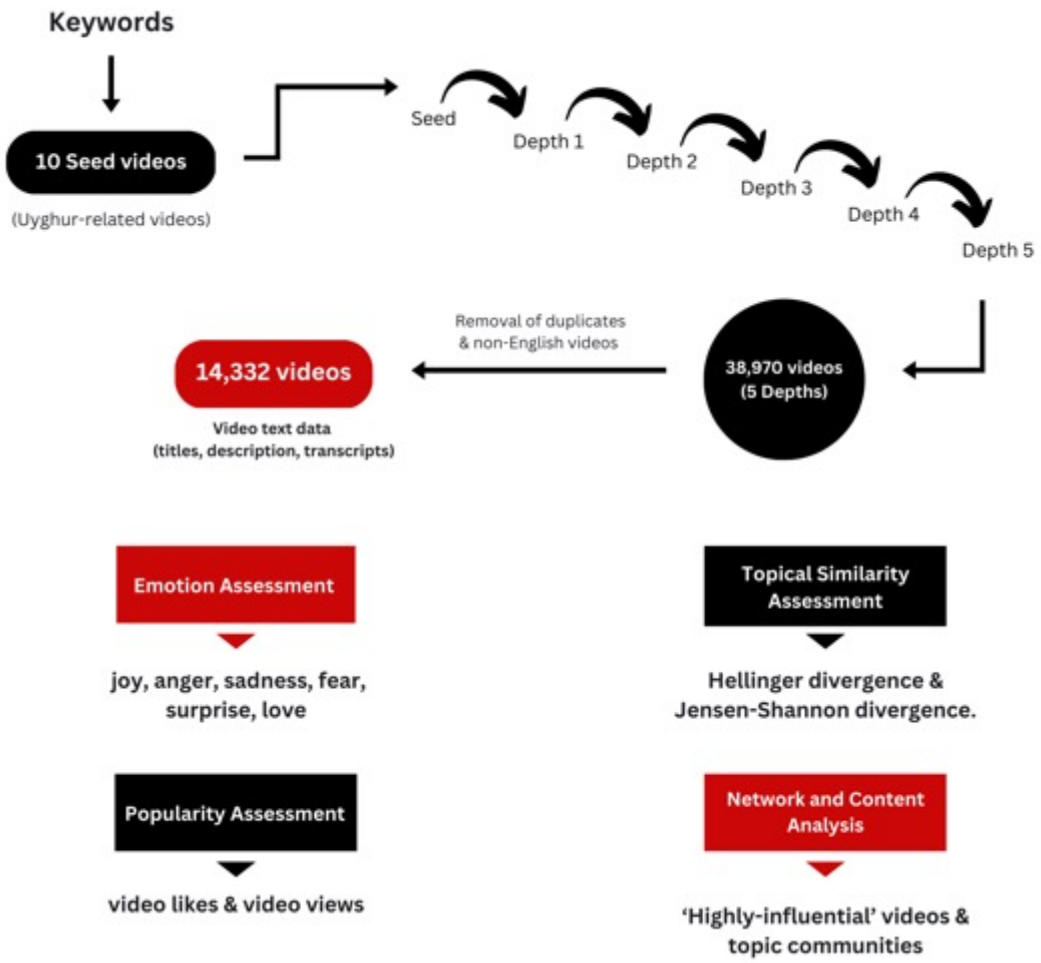


Top PageRank videos were removed weeks or months after their appearance in the recommendation network. Reason for content removal is violation of platform terms and services.

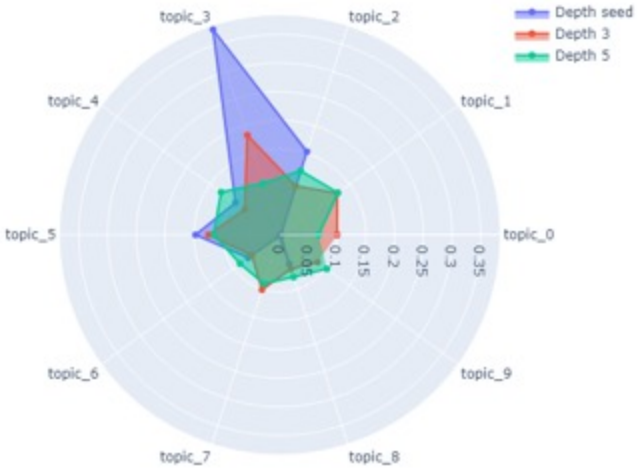


Information bubbles resulting from biased recommendations

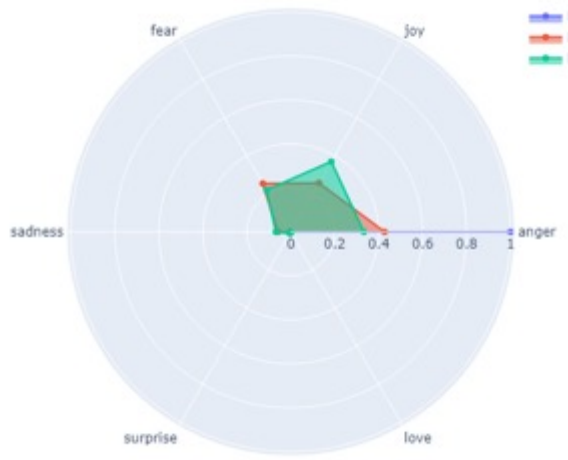
Exploiting AI Bias – Uyghur Narrative



Topic Drift



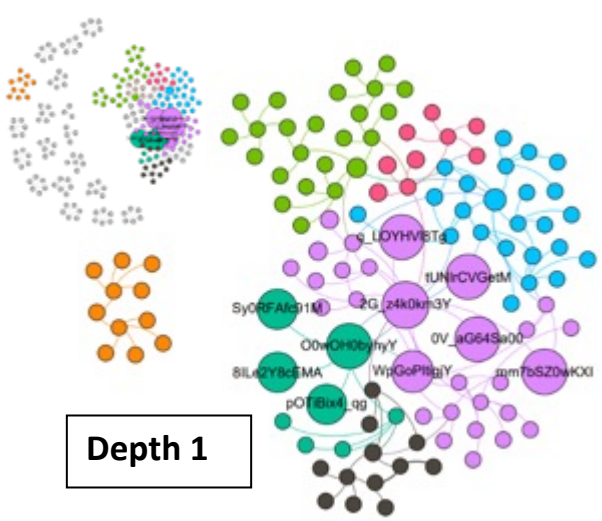
Emotion Drift



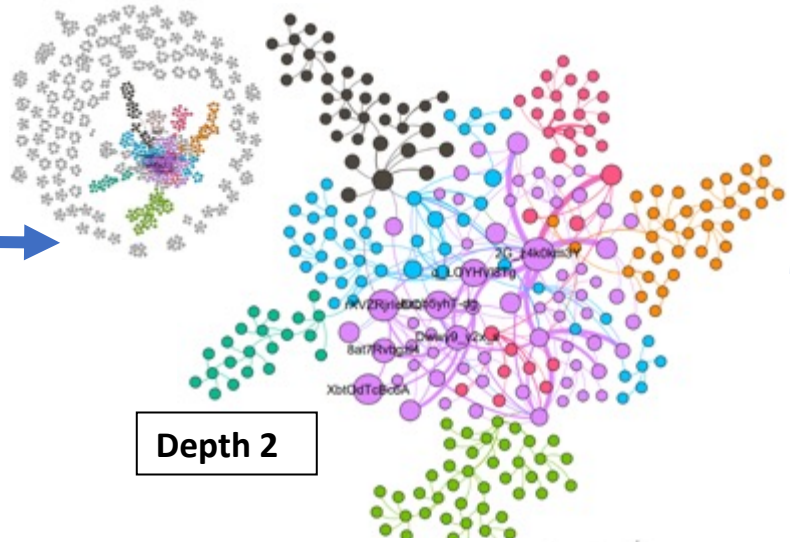
ECIR 2023, HUSO 2023, The Web Conference 2024, Jnl of SNAM 2024

These results are for YouTube regular videos. In YouTube shorts, the topic and emotion drift is much swifter. **Emotion steering through AI bias exploitation.**

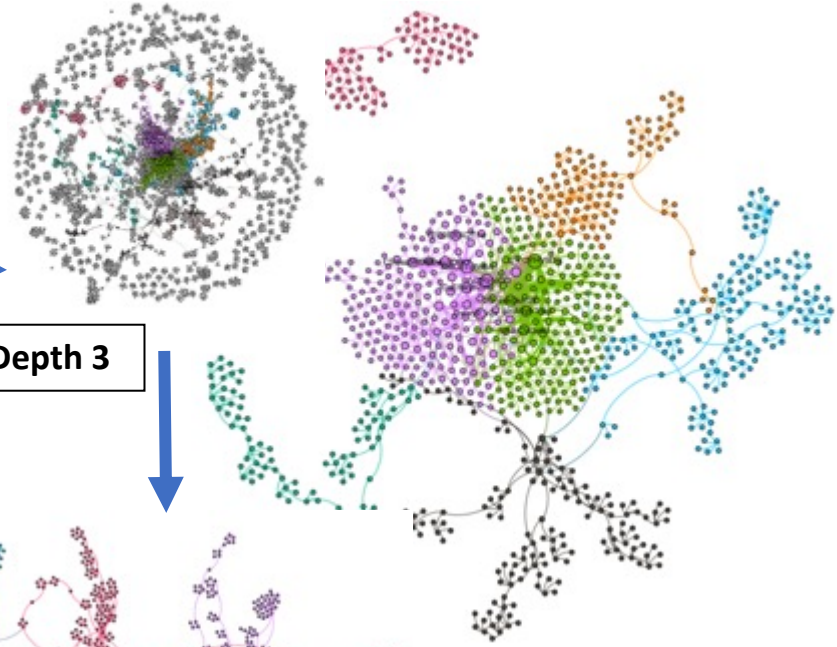
AI Bias ‘Hot Spots’



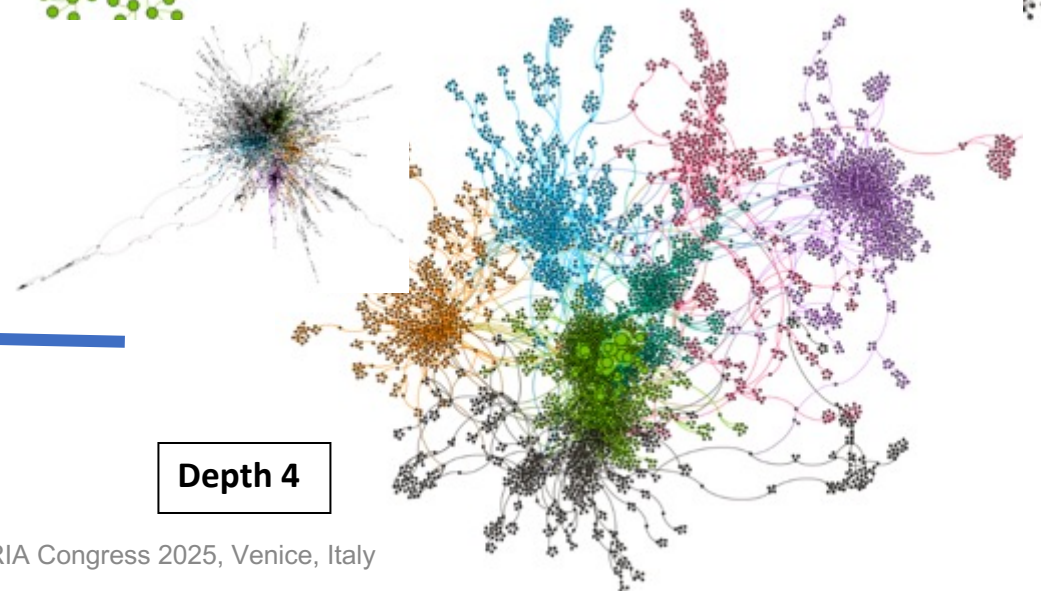
Depth 1



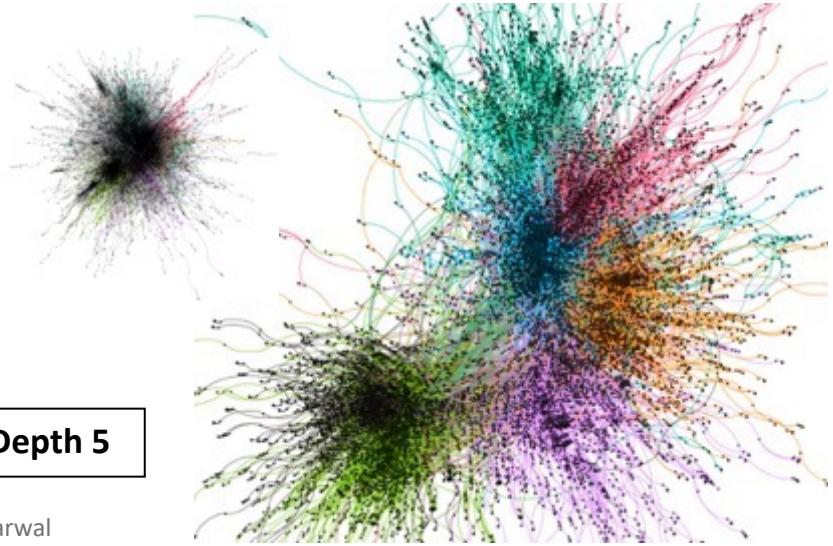
Depth 2



Depth 3



Depth 4

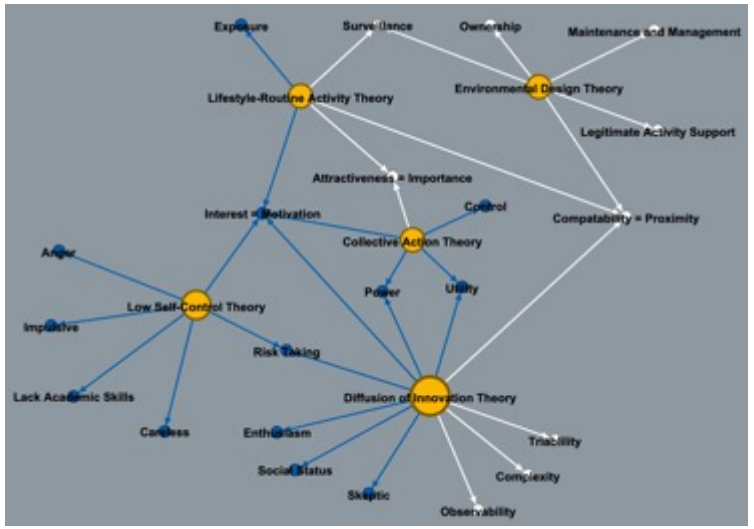


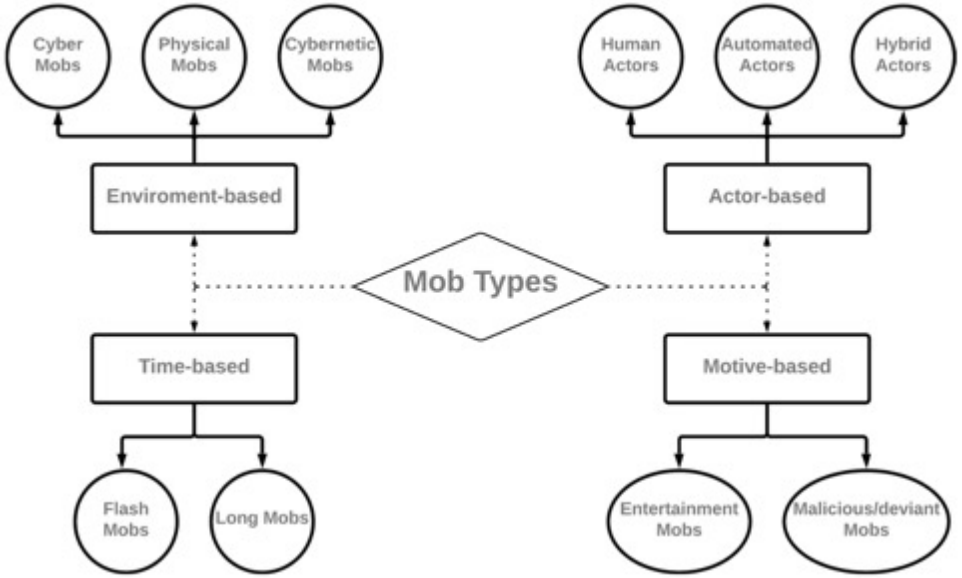
Depth 5

Civilizing and Humanizing AI

- AI and Agent-based modeling of deviant behaviors (OPSEC, disrupting operations)
- SCF and SNA informed methodologies to examine a strategic combination of multisource/multiplatform, multimedia data
- Influence, coordination, and reach of the digital activity of terrorist/extremist groups
- Multi-theoretic simulation with real-world data validation

(Social Networks Analysis & Mining, AMCIS, HICSS-21,22,23,24,25)



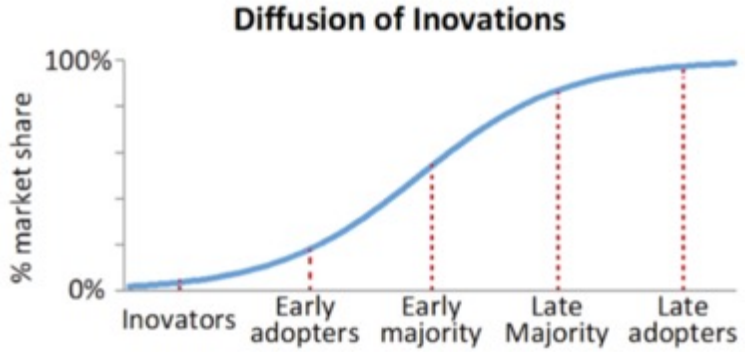


Deviant Group Characterization

ARO OUSD AFOSR ONR

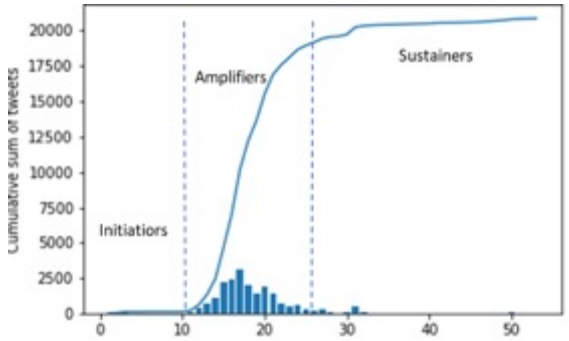
Information Actor Characterization & Resilience

Characterization of information producers

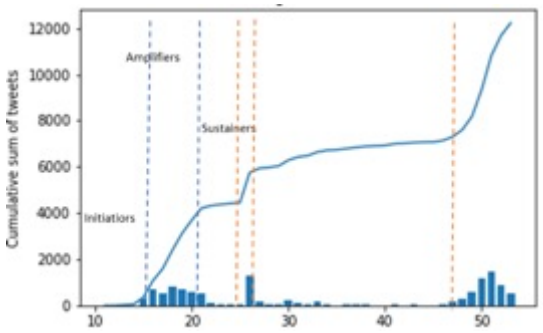


Diffusion of innovations, (1962)

Anti-US Tweets in Indo-Pacific



Anti-US TikTok in Indo-Pacific

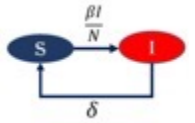


ICWSM, OSNEM, ASONAM, SNAM, HICSS, WWW, 2022, 2023, 2024, 2025

Characterization of information consumers

How do narratives spread? Who should be inoculated? Leveraging epidemiological modeling. Treat narratives like an epidemic → **infodemic** (SIS, SIR, SIRS, SEIZ)

SIS

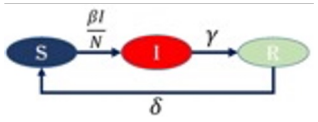


$$\begin{cases} \frac{dS}{dt} = -\frac{\beta SI}{N} + \delta I, \\ \frac{dI}{dt} = \frac{\beta SI}{N} - \delta I. \end{cases}$$

SIR

$$\begin{cases} \frac{dS}{dt} = -\frac{\beta SI}{N}, \\ \frac{dI}{dt} = \frac{\beta SI}{N} - \gamma I, \\ \frac{dR}{dt} = \gamma I. \end{cases}$$

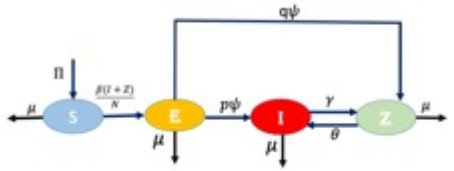
SIRS



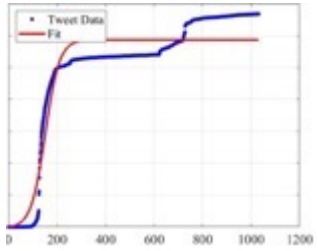
$$\begin{cases} \frac{dS}{dt} = -\frac{\beta SI}{N} + \delta I, \\ \frac{dI}{dt} = \frac{\beta SI}{N} - \gamma I, \\ \frac{dR}{dt} = \gamma I - \delta R. \end{cases}$$

S = susceptible, I = infected,
R = recovered, E = exposed,
Z = skeptic

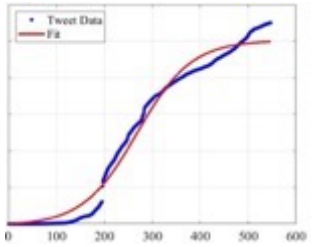
SEIZ



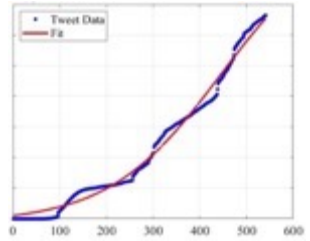
$$\begin{cases} \frac{dS(t)}{dt} = \Pi - \beta(I+Z)S(t) - \mu S(t), \\ \frac{dE(t)}{dt} = \beta(I+Z)S(t) - ((1-p)\psi E(t) - (1-q)\psi E(t) - \mu E(t), \\ \frac{dI(t)}{dt} = p\psi E(t) - (\gamma+\mu)I(t) + \theta Z(t), \\ \frac{dZ(t)}{dt} = q\psi E(t) + \gamma I(t) - (\theta+\mu)Z(t). \end{cases}$$



Anti-US (9.5% error)



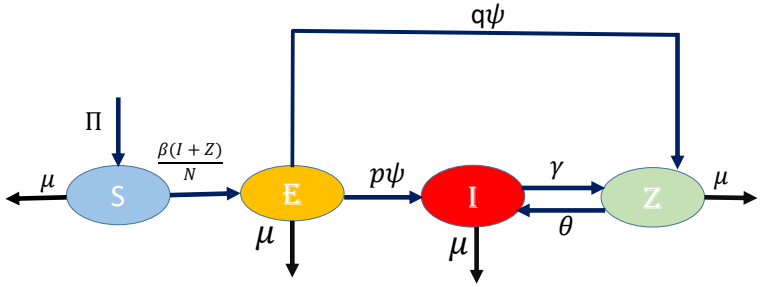
BRI (8.2% error)



Cheng Ho (6.9% error)

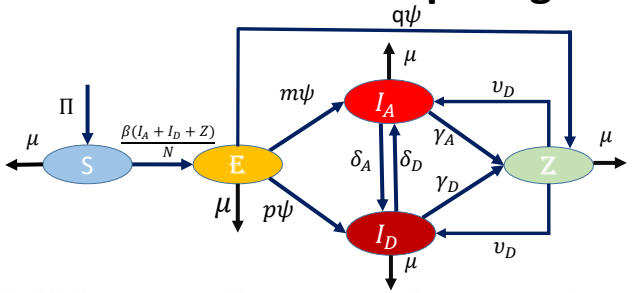
Modeling Narrative Spread

SEIZ model without competing narrative



$$\begin{cases} \frac{dS(t)}{dt} = \Pi - \beta(I+Z)S(t) - \mu S(t), \\ \frac{dE(t)}{dt} = \beta(I+Z)S(t) - ((1-p)\psi E(t) - (1-q)\psi E(t) - \mu E(t), \\ \frac{dI(t)}{dt} = p\psi E(t) - (\gamma+\mu)I(t) + \theta Z(t), \\ \frac{dZ(t)}{dt} = q\psi E(t) + \gamma I(t) - (\theta+\mu)Z(t). \end{cases}$$

SEIZ model with competing narratives



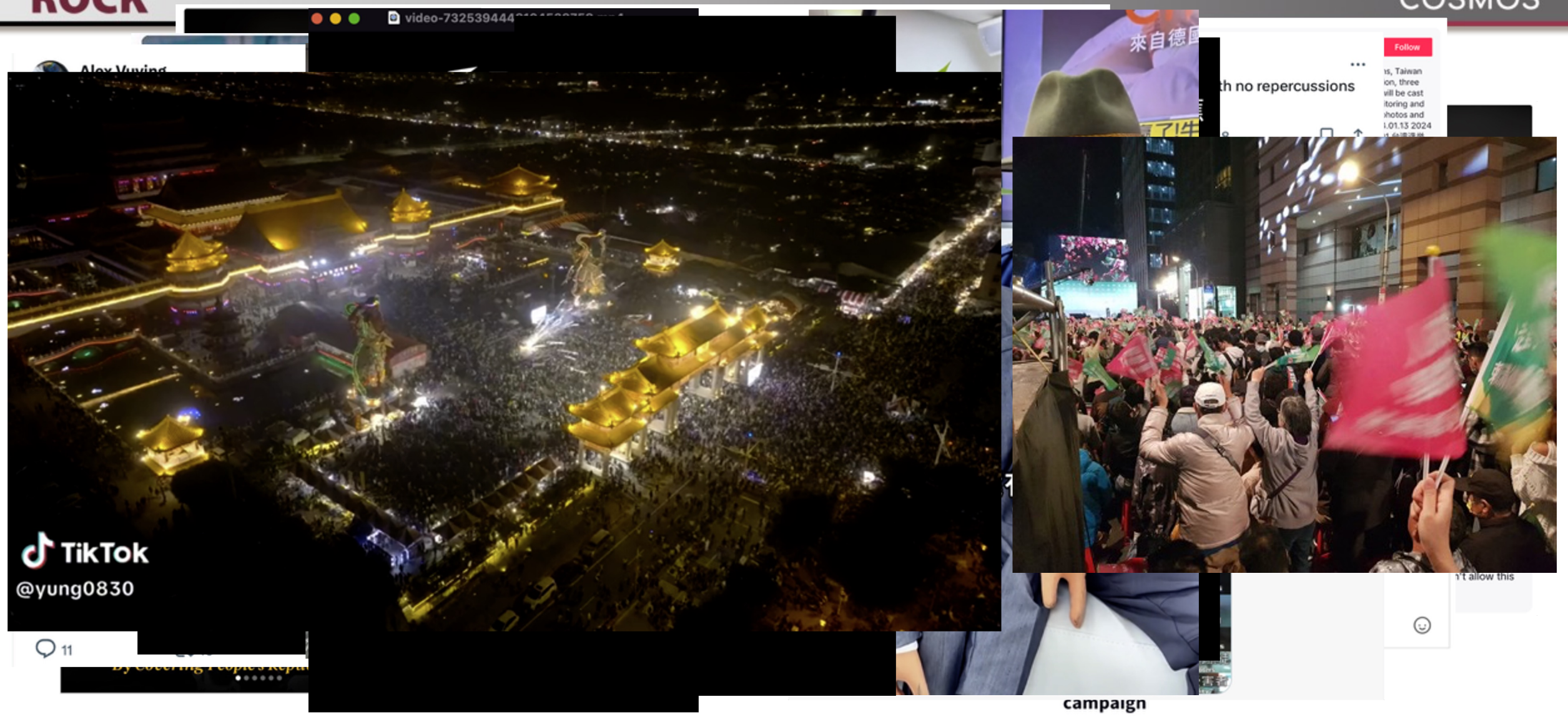
I_A and I_D are competing narratives

$$\begin{cases} \frac{dS(t)}{dt} = \Pi - \beta(I_A+I_D+Z)S(t) - \mu S(t), \\ \frac{dE(t)}{dt} = \beta(I_A+I_D+Z)S(t) - (1-m)\psi E(t) - (1-p)\psi E(t) - (1-q)\psi E(t) - \mu E(t), \\ \frac{dI_A(t)}{dt} = m\psi E(t) + \delta_D I_D(t) - (\theta_A+\mu+\gamma_A)I_A(t) + \psi_A Z(t), \\ \frac{dI_D(t)}{dt} = p\psi E(t) + \delta_A I_A(t) - (\theta_D+\gamma_D+\mu)I_D(t) + \psi_D Z(t), \\ \frac{dZ(t)}{dt} = q\psi E(t) + \gamma_A I_A(t) + \gamma_D I_D(t) - (\upsilon_A+\upsilon_D+\mu)Z(t). \end{cases}$$

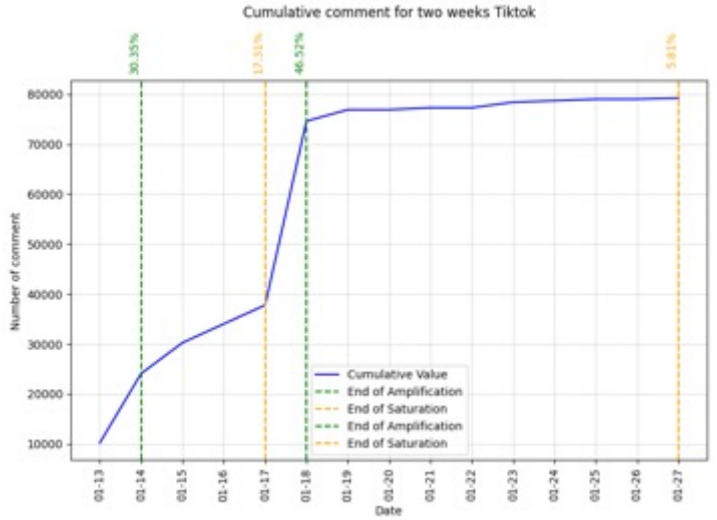
- Geopolitical narratives related to the Russia-Ukraine conflict on the messaging platform Telegram.
- Pro-Kremlin (I_A): “The world is waking up. The multipolar order is rising. The West’s empire is crumbling under its own hypocrisy. Stay strong, stand proud, and share the truth!”
- Pro-Ukraine (I_D): “They send missiles, but we send courage. They spread lies, but we stand for truth. They want to see us fall, but Ukraine only rises!”

- Error rates: SEIZ = 1.898; SEI_AI_DZ = 0.153
- **Narrative spread modeling accuracy improves when competing narratives are considered.**
- Transmission rates: I_A = 0.418; I_D = 0.179
- Shows **Pro-Kremlin narrative is more infectious than Pro-Ukraine** narrative (on Telegram).
- AI and LLMs are used for stance detection. Model validated on pre-annotated data for accuracy.

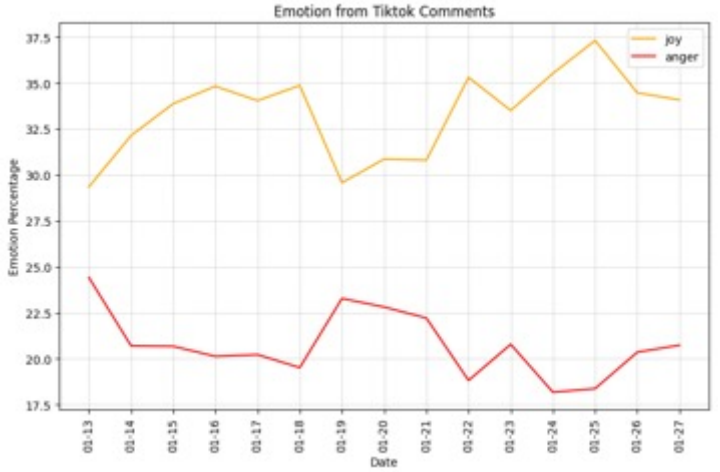
Social Media – A Positive Force



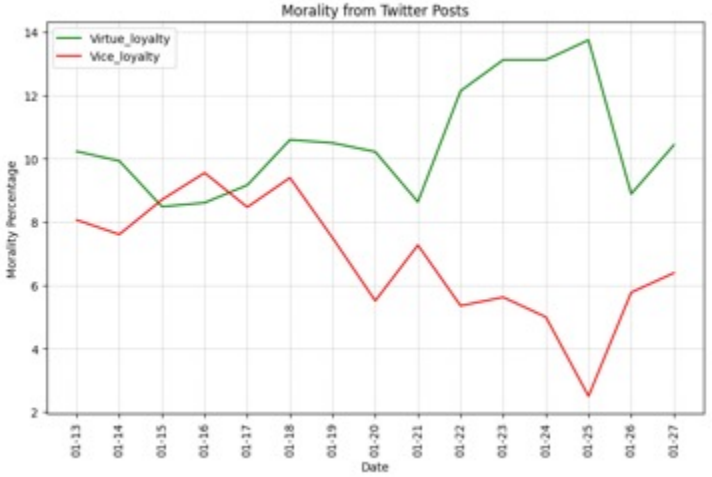
AI-based Multimedia Sensemaking



Modeling anti-disinformation campaign adoption.
When is a campaign successfully adopted?



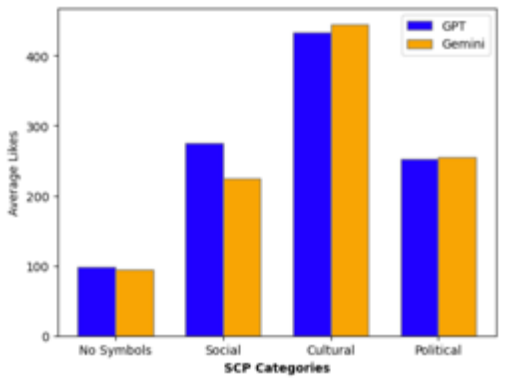
Stronger positive emotions about electoral process.

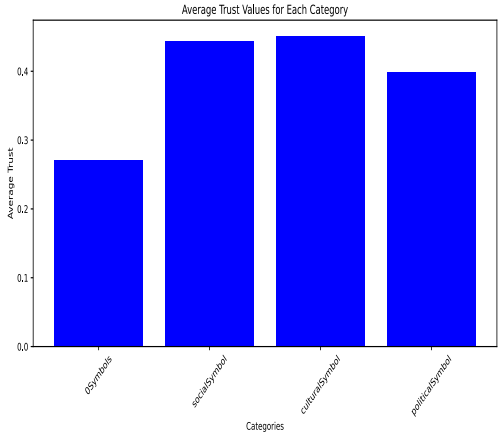


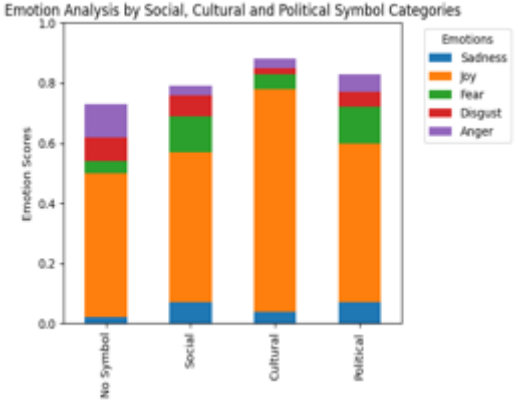
Trust restored in electoral process.

How to design a successful campaign message?
Social, Cultural, and Political Symbols!!!
Message consistency

- More engagement
- More positive reactions
- Faster trust restoration

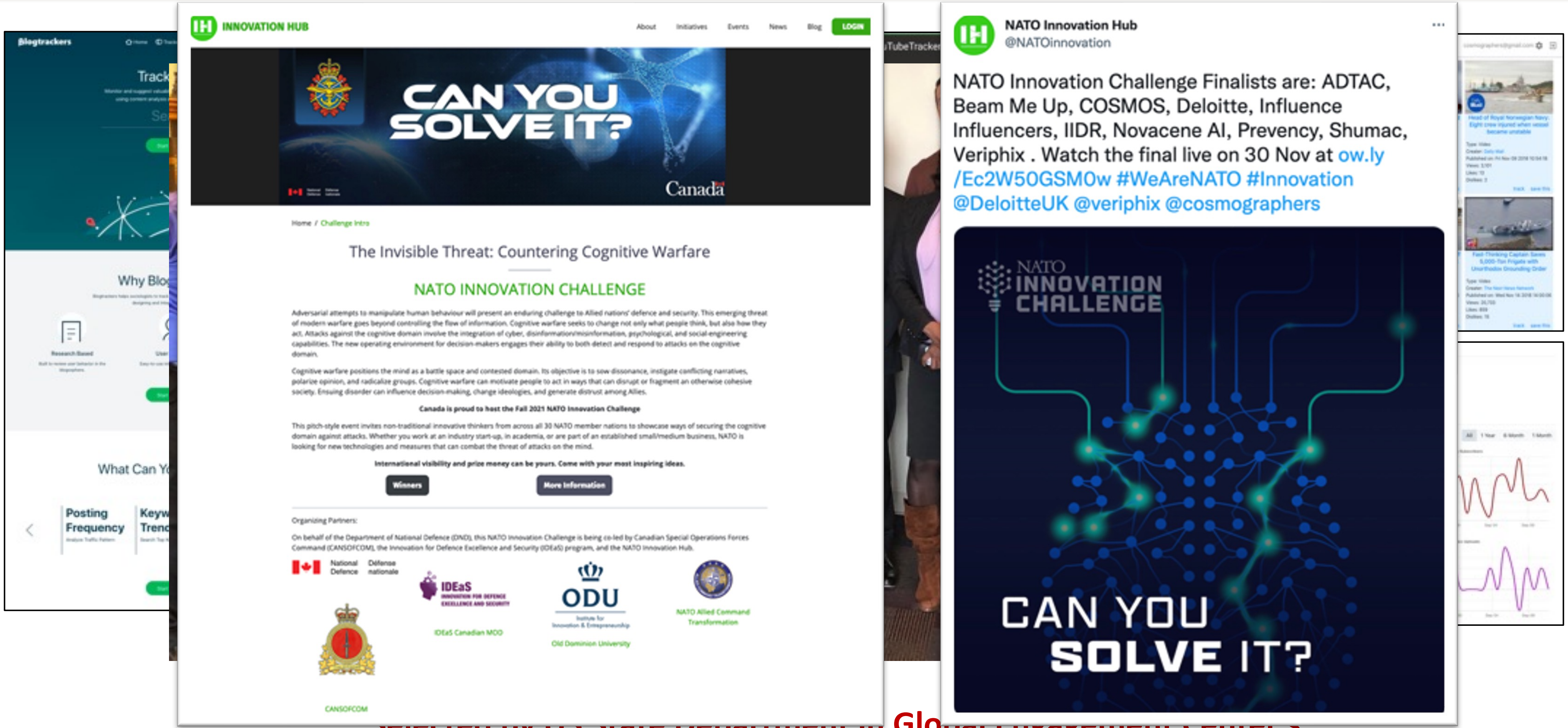






(Social Networks Analysis & Mining, ASONAM, SBP, WWW, ICWSM, HICSS 2024, 2025)

Technologies & Innovation



Selected by US State Department in Global Engagement Center's GOLDTech program to fight foreign-based propaganda

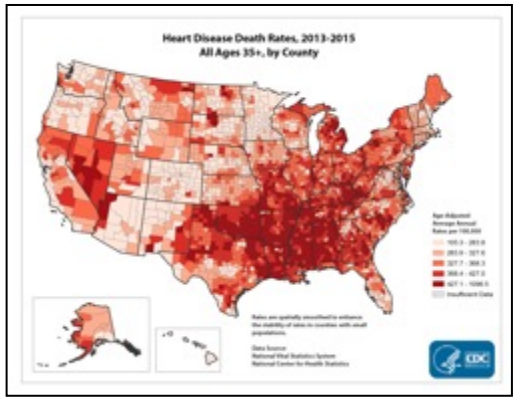
Recognized as top 10 finalists in the 2021 NATO Innovation Hub Challenge on "The Invisible Threat: Countering Cognitive Warfare" from 132 teams across the 30 NATO member nations.

Smart and Connected Health

Harnessing AI to address health disparities (e.g., CVD) across the Southern US.

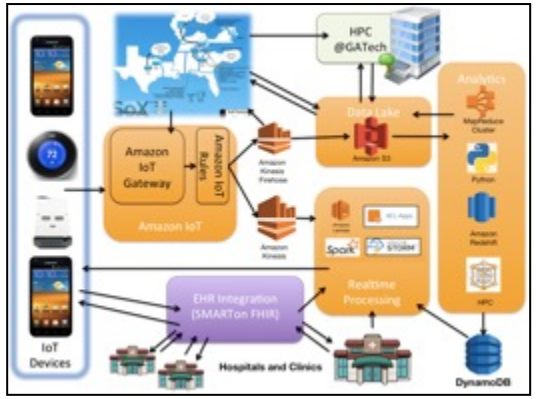
Funded by U.S. National Science Foundation (NSF) and Army Research Office (ARO)

NSF ARO



AI/ML based Data Fusion

EHR, wearable fitness devices, 'data from the wild'



Collective Action

Design

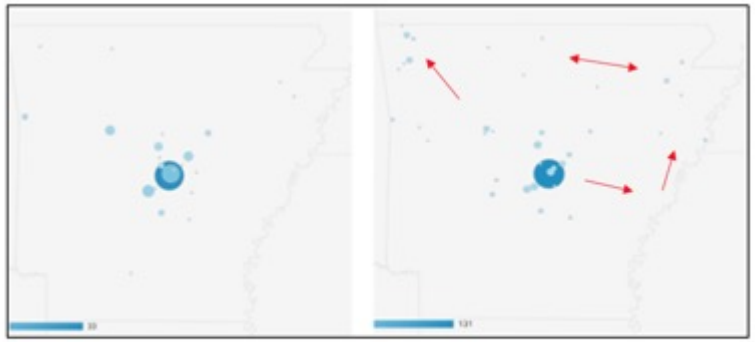
Technologies, Innovation, & Policymaking

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



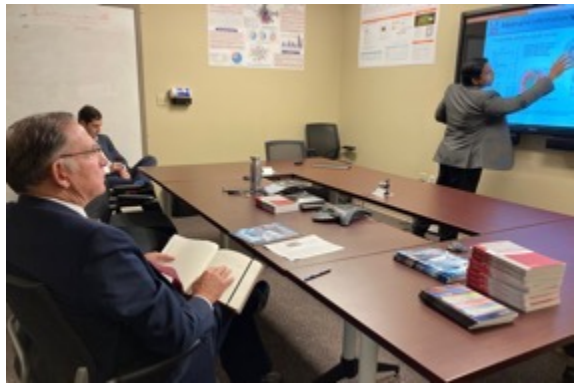
May 5, 2020 Jan 21, 2021

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

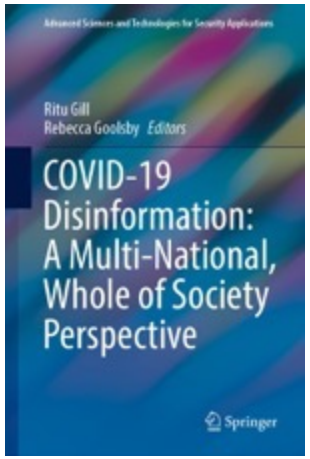
cosmos.ualr.edu/covid-19

Technologies, Innovation, & Policymaking



Briefing US Senator John Boozman

- COVID-19 Scam Tracker
- The capability was developed in partnership with the **Arkansas Office of the Attorney General.**
- Recognized by the **World Health Organization (WHO)** as one of the key technological innovations developed across the world to address COVID-19 pandemic.
- The application leverages our work on socio-cognitive threat modeling, education, and awareness efforts to assist policymakers.



NATO Research and Technology Group RTG HFM-293

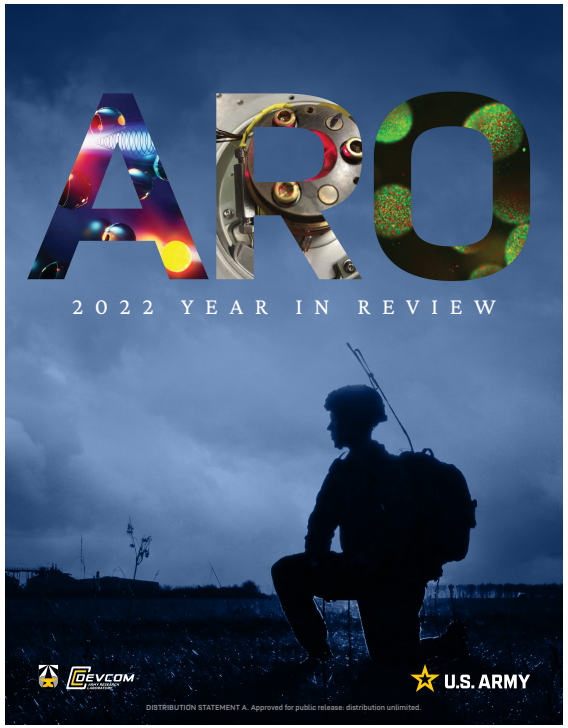
NATO STO-HFM-361
Mitigating Cognitive Warfare

ARA Fellow Dr. Nitin Agarwal's Partnership with the AR Attorney General to Combat COVID Disinformation, Scams

"Scammers are working overtime to exploit coronavirus fears. We are grateful for the ongoing efforts in Arkansas by Dr. Agarwal and his team at UA Little Rock helping identify the schemes thieves employ so we can stop these fraudulent activities, hold offenders accountable and prevent Arkansans from being fooled by bogus claims."

- U.S. Sen. John Boozman (R-Ark.)

Technologies, Innovation, & Policymaking



HUMANS IN COMPLEX SYSTEMS

SOCIAL AND COGNITIVE NETWORKS PROGRAM

Dr. Edward T. Palazzolo
Program Manager

Dr. Palazzolo completed his undergraduate studies in 1997 at the State University of New York at Buffalo as a double major in Psychology and Communication. He received his M.A. from the State University of New York at Buffalo in Interpersonal and Organizational Communication in 1999. He earned his Ph.D. at the University of Illinois Urbana-Champaign in 2003 in Organizational Communication and Knowledge Management.

He came to ARO in 2014 as the Program Manager for the Social and Cognitive Networks Program.

Current Scientific Objectives

1. Develop fundamental science (nonclinical) in support of Community Cognitive Resilience that, if successful, will help the military, veterans, and civilians transition from illness to wellness with respect to post-traumatic stress disorder (PTSD), depression, anxiety, chronic pain, suicidal ideation and prevention, substance abuse, and disinformation.
2. Discover the fundamental principles governing human–agent teaming activities that support designing and maintaining high-performance teams that, if successful, will allow the Army and Joint Staff to engineer high-performance teams with specified characteristics to satisfy mission requirements, and enable teaming with unprecedented coordination across multiple defense organizations while improving Soldiers' cognitive resilience.
3. Create verifiable models of networked human behavior by bridging social science theories with computer science techniques and engineering precision that, if successful, will create the ability to forecast societal opinions and shifts with pinpoint accuracy, especially with potential for real-world effects, to support Army and Joint Operations by providing support for decision-making.

This success was made possible by:

Dr. Edward T. Palazzolo; Humans in Complex Systems, ARO

Dr. Fredrick Gregory; Humans in Complex Systems, ARO

Citations:

Zhou, D. et al. Proc. Natl. Acad. USA. 120, e2201074119 (2023).

Jovanova, M. et al. PsyArXiv (2022). https://psyarxiv.com/yw7s3/

McGowen, A. L. et al. BP:GOS. 2, 432-439 (2021).

SUCCESS STORY

Leveraging Mind–Body–Community Connections to Reduce Alcohol Abuse

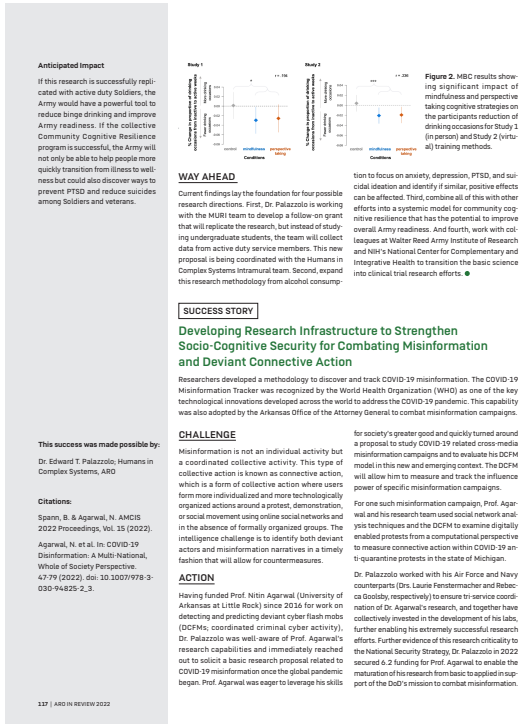
Researchers discovered a causal relationship between a focused mindset and lower alcohol consumption: Mindfulness and perspective taking causally reduce alcohol cravings and real-world drinking. Reducing alcohol consumption and abuse has a direct impact on Army unit readiness and pain management of Soldiers (active duty, Reserve, and National Guard), civilians, and veterans.

CHALLENGE

The scientific community is at the nascent stage of understanding how the mind–body is coupled at the intersection of biology and psychology. Until this research, there have been no clear, coherent models pushing beyond the mind–body connection with the intent to understand how one's social network influences their cognitive network, which in turn influences their neural network, and vice versa. That is, how can we establish a scientific theory describing the impact of people's social connections, with the messages received and the changes to the way they think? And how does the way people think change the way their brains are wired? In turn, how does the way people's brains are wired influence the way they think and influence the people they choose to spend time with and the messages they choose to consume? Collectively, these questions drive us toward the science of Community Cognitive Resilience.

ACTION

Dr. Palazzolo began building a research program in 2015 around the idea of mind–body–community (MBC) connections to bring together his backgrounds in psychology, communication, social networks, and knowledge management with his personal passion for mindfulness and hypnotherapy as potential force multipliers for managing and improving the cognitive dimension and, thereby, the individual's overall well-being. With this vision in mind, he teamed up with Dr. Fred Gregory, ARO's Program Manager for Neurophysiology of Cognition, and together they successfully competed a Multi-disciplinary University Research Initiative (MURI) topic and secured funding for a research



Anticipated Impact

If this research is successfully replicated with active duty Soldiers, the Army would have a powerful tool to reduce binge drinking and improve Army readiness. If the collective Community Cognitive Resilience program is successful, the Army will not only be able to help people more quickly transition from illness to wellness but could also discover ways to prevent PTSD and reduce suicides among Soldiers and veterans.

This success was made possible by:

Dr. Edward T. Palazzolo; Humans in Complex Systems, ARO

Citations:

Spann, B. & Agarwal, N. AMCIS 2022 Proceedings, Vol. 15 (2022).

Agarwal, N. et al. In: COVID-19 Disinformation: A Multi-National, Whole of Society Perspective. 47-79 (2022). doi: 10.1007/978-3-030-94825-2_3.

Figure 2. MBC results showing significant impact of mindfulness and perspective taking cognitive strategies on the participants reduction of drinking occasions for Study 1 (in person) and Study 2 (virtual) training methods.

WAY AHEAD

Current findings lay the foundation for four possible research directions. First, Dr. Palazzolo is working with the MURI team to develop a follow-on grant that will replicate the research, but instead of studying undergraduate students, the team will collect data from active duty service members. This new proposal is being coordinated with the Humans in Complex Systems Intramural team. Second, expand this research methodology from alcohol consumption to focus on anxiety, depression, PTSD, and suicidal ideation and identify if similar, positive effects can be affected. Third, combine all of this with other efforts into a systemic model for community cognitive resilience that has the potential to improve overall Army readiness. And fourth, work with colleagues at Walter Reed Army Institute of Research and NIH's National Center for Complementary and Integrative Health to transition the basic science into clinical trial research efforts. ●

SUCCESS STORY

Developing Research Infrastructure to Strengthen Socio-Cognitive Security for Combating Misinformation and Deviant Connective Action

Researchers developed a methodology to discover and track COVID-19 misinformation. The 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. This capability was also adopted by the Arkansas Office of the Attorney General to combat misinformation campaigns.

CHALLENGE

Misinformation is not an individual activity but a coordinated collective activity. This type of collective action is known as connective action, which is a form of collective action where users form more individualized and more technologically organized actions around a protest, demonstration, or social movement using online social networks and in the absence of formally organized groups. The intelligence challenge is to identify both deviant actors and misinformation narratives in a timely fashion that will allow for countermeasures.

ACTION

Having funded Prof. Nitin Agarwal (University of Arkansas at Little Rock) since 2016 for work on detecting and predicting deviant cyber flash mobs (DCFMs; coordinated criminal cyber activity), Dr. Palazzolo was well-aware of Prof. Agarwal's research capabilities and immediately reached out to solicit a basic research proposal related to COVID-19 misinformation once the global pandemic began. Prof. Agarwal was eager to leverage his skills for society's greater good and quickly turned around a proposal to study COVID-19 related cross-media misinformation campaigns and to evaluate his DCFM model in this new and emerging context. The DCFM will allow him to measure and track the influence power of specific misinformation campaigns.

For one such misinformation campaign, Prof. Agarwal and his research team used social network analysis techniques and the DCFM to examine digitally enabled protests from a computational perspective to measure connective action within COVID-19 anti-quarantine protests in the state of Michigan.

Dr. Palazzolo worked with his Air Force and Navy counterparts (Drs. Laurie Fenstermacher and Rebecca Goolsby, respectively) to ensure tri-service coordination of Dr. Agarwal's research, and together have collectively invested in the development of his labs, further enabling his extremely successful research efforts. Further evidence of this research criticality to the National Security Strategy, Dr. Palazzolo in 2022 secured a 2 funding for Prof. Agarwal to enable the maturation of his research from basic to applied in support of the DoD's mission to combat misinformation.

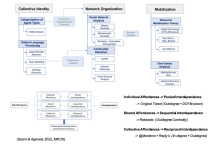


Figure 3. The Connective Action Model – OR – Socio-technical framework for connective action comprised of Collective Identity, Network Organization, and Mobilization.

RESULT

Prof. Agarwal developed a multidisciplinary approach that addresses gaps in social science research by applying a socio-technical approach to measure the collective identity, network organization, and network mobilization features surrounding collective and connective action movements. He then combined that framework for connective action with his DCFM model (which focuses on utility, interest, control, and power) and an integrated model called focal-structure analysis (which uses the individual-level measure of the users' betweenness centrality value, and the group-level measure utilizing the spectral modularity method employed to measure the groups' influence in the entire network) to identify deviant actors pushing misinformation narratives.

Using this socio-technical approach on the Michigan Lockdown Protest example, Prof. Agarwal's team collected data from Twitter focused on #LetMiPeopleGo, #MiLeg, #Endthelockdown, and #MichiganProtest during the April 1 to May 20, 2020, time frame. This resulted in 16,383 tweets from 3,632 nodes across 382 groups. They further focused their research on the five most powerful groups. Utilizing their connective action, DCFM, and a focal structure analysis approach, their research showed powerful coordination among conspiracy groups calling for protest and actions against Michigan Gov. Whitmer. Subsequently, the FBI later unraveled a plot to kidnap Gov. Whitmer, providing real-life evidence of the efficacy of the approach.

This work was so successful, it was identified by the World Health Organization (WHO) as a top technology to fight COVID-19 misinformation. Moreover, the Arkansas Attorney General's office partnered with Dr. Agarwal to identify COVID-19 misinformation in the state of Arkansas and promoted Dr. Agarwal's website where he catalogs the misinformation and provides fact checking from reliable sources. Lastly, the work has been incorporated into a NATO Research Task Group book on the Multi-National, Whole of Society challenge of COVID-19 misinformation.

WAY AHEAD

The research from these grants supports the development of critical research infrastructure to strengthen socio-cognitive security. These investments enable further enhancement of the science and the scientists to actively work on cognitive research necessary for cybersecurity. To further develop these research models and to advance the work, Prof. Agarwal's next grant will move from basic research to applied research for developing socio-computational capabilities to evaluate emerging social-cyber threats. Successful outcomes of this research are shared with the G39 through Aaron Chan, Deputy for the Theater Information Advantage Detachment at United States Army Pacific (USARPAC). ●

Figure 4. Successful transitions of Dr. Agarwal's research on COVID-19 misinformation. (A) the World Health Organization (WHO); (B) Arkansas Attorney General Leslie Rutledge partners with Dr. Agarwal to identify misinformation and to educate the public; and (C) NATO Science and Technology Organization leverages Dr. Agarwal's work and incorporated it in a recent book by NATO members.

CHAPTER 3
SUCCESS STORIES

ARL Competencies:

Humans in Complex Systems

Military Information Sciences

Results

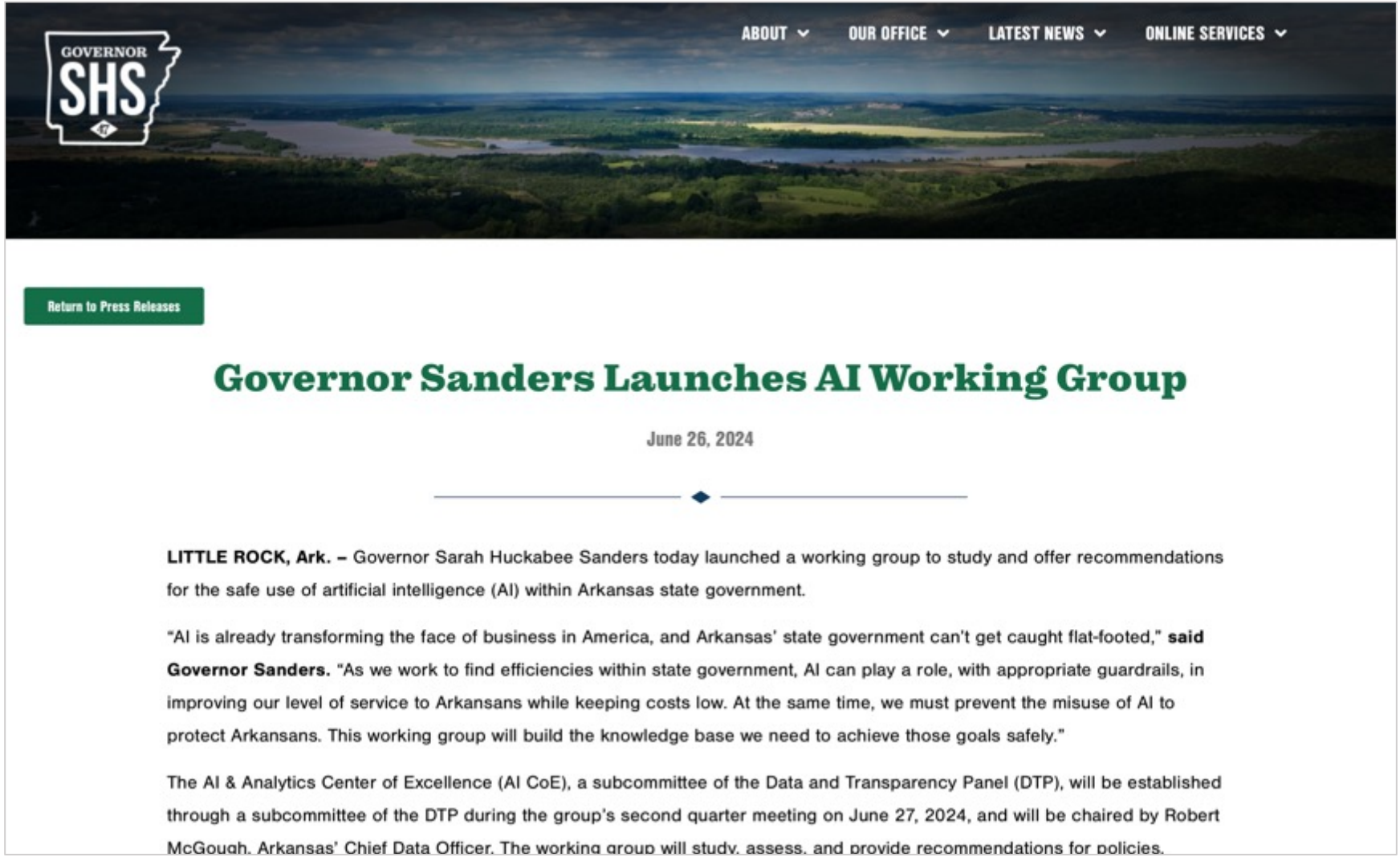
- Developed the COVID-19 Misinformation Tracker, which was recognized by the WHO as one of the key technological innovations used to address the COVID-19 pandemic.
- Developed a Computational Framework for Analyzing Social Behavior in Online Connective Action (Top Paper Award at Americas Conference on Information Systems 2022).

Anticipated Impact

This research may help design strategies that will help individuals, communities, and military units become cognitively resilient to misinformation campaigns.

Research highlighted in the **US Army Research Office** "Year in Review" magazine as a success story for the **Social and Cognitive Networks Program**

Technologies, Innovation, & Policymaking



Training Operators and Practitioners

We've conducted training for PAO, info-ops, psy-ops officers from NATO member nations at StratCom COE, US CYBERCOMMAND, US Marine Information Group (3-MIGs)

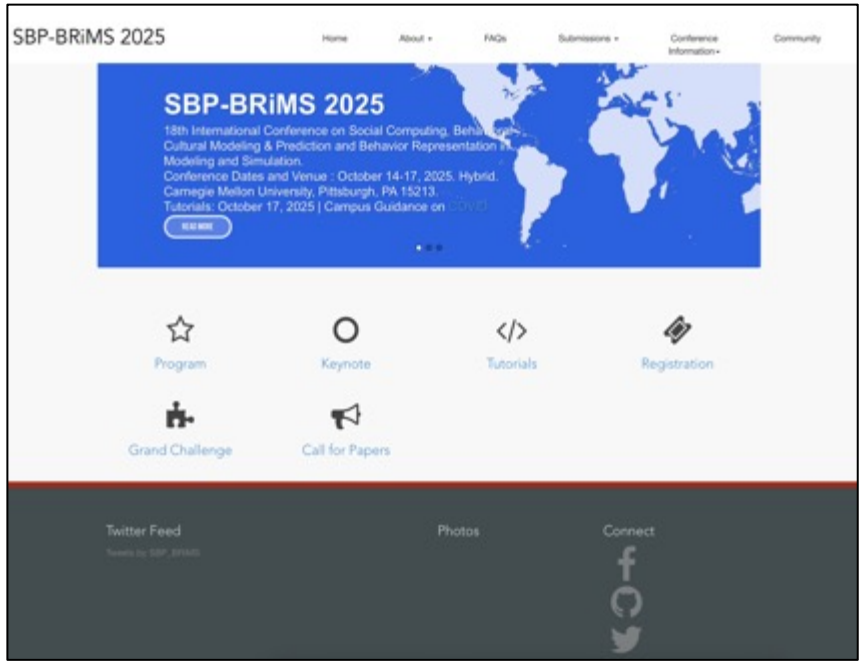
Cosmographers' Achievements

- Our graduates are at leadership positions at many **Forbes 100 companies**
- Won over 20 **Acxiom Scholarships**
- **Face of Tech** Scholarships
- **LewerMark** Scholarships
- Recognitions by **DoD, NATO, WHO**
- Numerous **US DoD travel awards**
- Presented over 300 studies at **top-tier international conferences**
- Won over **40 best paper awards**

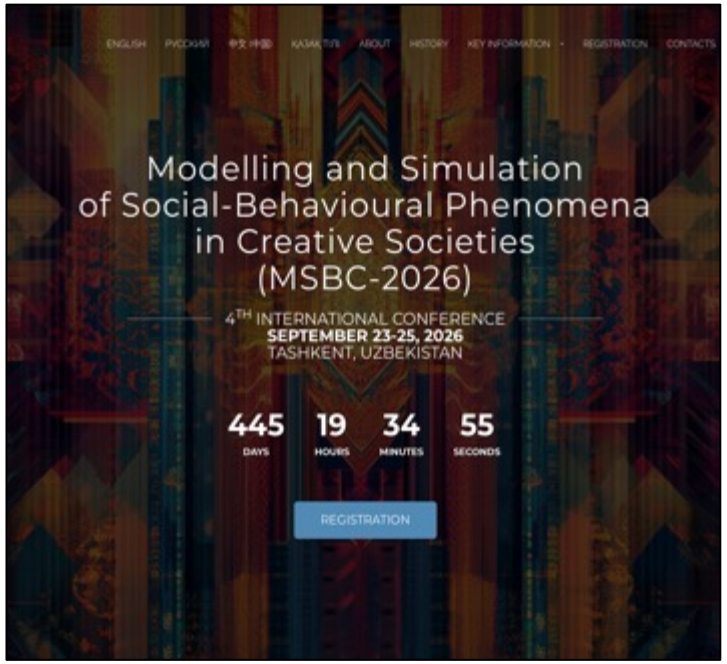
Average starting salary over $150,000

Educating Future-Ready Innovators

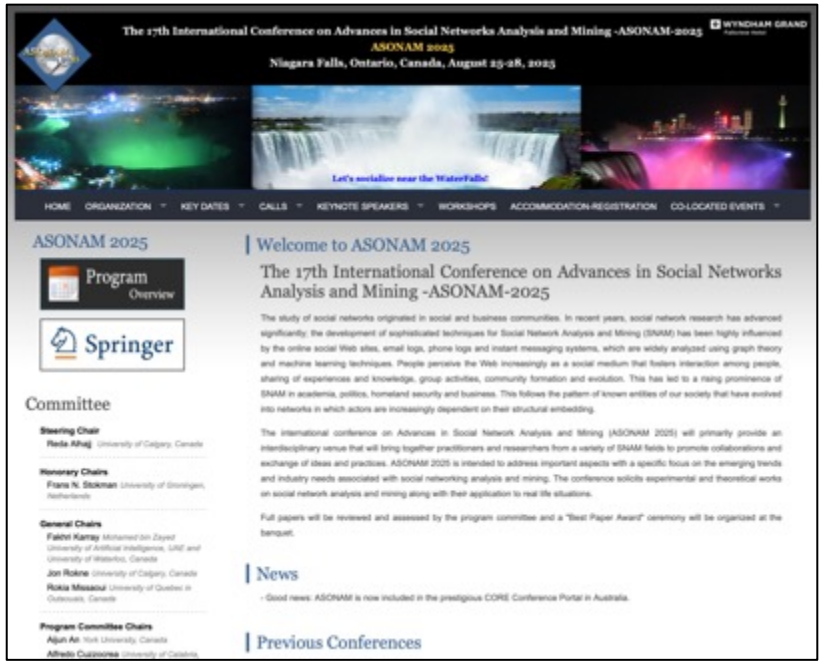
Educating Future-Ready Innovators



International Social Computing Conference
SBP 2025, CMU, Pittsburgh, USA



International Modeling and Simulation
Conference, MSBC 2026, Uzbekistan



International Conference on Advances in Social
Network Analysis and Mining,
ASONAM 2025, Niagara Falls, Canada

Research Opportunities

- **5-year $15 million grant from the U.S. Department of Defense, PI: Nitin Agarwal, Ph.D.**
- 20+ Graduate Research Assistants (MS/PhD)
  ($27k, Full Tuition coverage, Health Insurance covered)
- 10+ Postdoctoral fellowships
  ($60k - $110k, Full benefits, Health insurance)
- 10+ Full stack developer, Dev Ops, Data engineer
  ($60k - $100k, Full benefits, Health insurance)
- 2 System Engineer
  ($65k, Full benefits, Health insurance)

Apply at https://cosmos.ualr.edu/careers/
Contact Prof. Nitin Agarwal (nxagarwal@ualr.edu)

Thank You!

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