Estimating Return on Impact of Misinformation Intervention

An Initial Exploration of the Use of the Business Case for Estimating Return on Investment of Intervention and Incentivizing Information Sharing

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May 8, 2022

Version 1.0

Abstract:

Misinformation, although not a novel phenomenon, now propagates much more rapidly, due to denser and quicker-spreading networks and tools that make adversarial narrative influence campaigns both easier to generate, and increasingly difficult to detect. Moreover, little work has been done to quantify the financial impacts of misinformation at an organisational level, leaving the cost and return on investment of response largely obscured. This white paper offers an operational approach toward defining the financial impacts of misinformation and explores potential approaches to analysing and integrating accounting of response costs, opportunity costs, and reputational risk. The incentivization of response reporting and information sharing is discussed, and a series of recommendations for continued work are provided.

Keywords: Misinformation, Information Operations, Markets, Market Design, Mechanism Design, Social Systems Engineering

Introduction

While Common Vulnerabilities and Exposures (CVE) databasing is now standard practice in cybersecurity, enabling common defence across sectors through a form of crowdsourcing. Such a federated approach has not yet become standard practice for psychosocial matters such as: online harassment, mis and disinformation, and narrative influence events - some of which are capable of mass disruption, such as changing the outcomes of democratic elections and referenda.

Recent work, such as the pattern collection within the recent book “The Narrative Campaign Field Guide” [1], has indicated that CVE-like databasing of such psychosocial matters would be a valid and valuable approach for responding to misinformation, but more work is needed to understand what tools would be necessary to facilitate this, and in what use-cases it might be most valuable. There have been reasonable efforts elsewhere directed toward CVE-styled detection and sharing of vulnerabilities and exploits in the information environment [1–3], but limited efforts appear to have been made on sharing of responses and informing potential developers of tools for facilitating and incentivizing CVE-related crowdsourcing solutions. Incentive alignment for good-faith contributions is a necessary component of any crowdsourcing solution, and in order to design for incentive alignment, there must be a means of approximating the potential return on choices. Key challenges remain, however, in that there is limited available reference work addressing the return on the investment or broader questions of costs and other impacts regarding the nature and extent of effort given to particular responses to various forms of information vulnerabilities.

This white paper aims to explore the potential for actors to collaborate in sharing practises and responding to mis- and disinformation, how incentives can be identified and how they can be communicated, and how to compare practises through estimations of return on investment, given costs and relative impact. First, we offer some background on what work has been done in adjacent domains on valuing information and relevant impacts. We then explore the potential to quantify the costs and impacts of response and how business cases can be created to invest in response capability, estimate impacts, and extrapolate estimates to non-commercial use cases. Finally, we offer recommendations for developers of related tools and for future work.

Past Work on Measuring Costs of Information Impacts

Among the most scientifically rigorous attempts to quantify the costs of misinformation-related impacts are those found in game theory [4] and biology. In biology, the causes and consequences of misinformation have been modelled using both generalised toy-problems built on game-theoretic models [5] and in highly specific areas, such as those related to pheromone and biotic noise eavesdropping phenomena where, for example, insects attempt to conceal their activities from other species [6,7]. Attempts to make use of cost-analysis related to misinformation in real world scenarios outside of biology appear to build on similar game-theoretic frameworks [8].

In the case of game theory in toy-problems and biology, rigour is enabled through very tightly constrained scope. Outside of these spaces, attempts to quantify impacts of influence strategies, such as those related to marketing and branding [9], by merit of their intent, are limited due to difficulties in observability. This being the case, post-mortems and *a posteriori*, experience-driven approaches are the standard, using integration of human heuristics and "tradecraft" in order to cope with the complexities of implementing and adapting campaigns [1]. These difficulties are not specific to measuring information impacts - measurement of phenomena within any complex system is notoriously difficult, to such an extent that complex systems are often characterised by the difficulty in tethering phenomena to second order effects or to predict impacts even with complete observability of starting states.

In terms of the analysis of and implementation of interventions within complex social systems, the use of frameworks which consider the use of "attractors", or centres of gravity within narratives and demographics have been suggested as a sufficient foundation for approaching data collection and qualitative interpretation [1,10,11]. In terms of quantitative analysis, as evidenced by the usefulness of the neural net, there is a value in restraining analysis and audit attempts to the discrete inputs and outputs that are relevant to outcome and objectives, as opposed to attempting to analyse the intermediate black box or "hidden layer" itself, which may provide illusory results even with full observability.

Determining Information Impacts

Here we consider approaches for defining and estimating the impacts and the value of impacts of information exposures and interventions.

Defining Information Impacts

There are myriad methods to define the impacts of information depending on the specific use-case and level of abstraction applied. For example, evaluating information impact, and even the definitions of "information impact" itself, may differ wildly between those proffered for different purposes, for example for analyses of narrative influence campaigns by foreign state actors attempting to influence elections versus those proffered within the context of pure information science. Even at similar levels of abstraction of what constitutes abstraction, definitions offered within information science may differ from those offered within the cognitive sciences, or within integrative frameworks which overlap with these domains. However, regardless of the model one decides to apply (e.g., Shannon's model of information exchange, or the more recent active inference cognitive modelling framework) to evaluate abstract information impacts, the discrete impacts of a narrative influence campaign, or the relationship between information and its impacts generally, the following framework for describing categories of information impacts, adapted from prior work in information science, is sufficiently general to be of value:

> **Impact on Behaviour.** A marked change in behaviour or probability of the behaviour in the agent.
>
> **Impact on Knowledge.** A change or magnitude of change in the knowledge of a recipient.
>
> **Impact on Search.** A marked change in how the agent searches for information.
>
> **Impact on the Social System.** A marked change in behaviour or structure at the level of social unit or organisation.
>
> [12]

Each of these impacts is interconnected and overlaps with one another - however, each impact is of sufficient importance and interest to justify their separation, as has been noted work elsewhere [12]. This categorization of impacts maps to both the active inference

action-perception loop and to the OODA (observe, orient, decide, act) decision making model (see Figure 1), and this direct mapping to a cognitive model helps to set practical boundaries on analysis for succeeding sections here.

For example, we can initially rule out analysis of the impacts of information on knowledge *itself* (i.e. in memory), as there would be highly limited observability - though with sufficient argument-mining and claims related data pipelines informed by humans-in-the-loop, aggregate modelling of hidden cognitive state for real world applications may become more practicable [11]. Further, we can state that where behaviour and search pattern are well-defined and observable, we can endeavour to measure impact, without the need to measure or observe the intermediate processor which consumes sense data and generates output behaviour. So long as scope, and focus on discrete inputs (exposures to well-defined information packages or interventions) and outputs (behaviour and search pattern) are maintained, coarse-grained analysis at the level of groups may be possible, as evidenced by the formalisation of advertising [13].

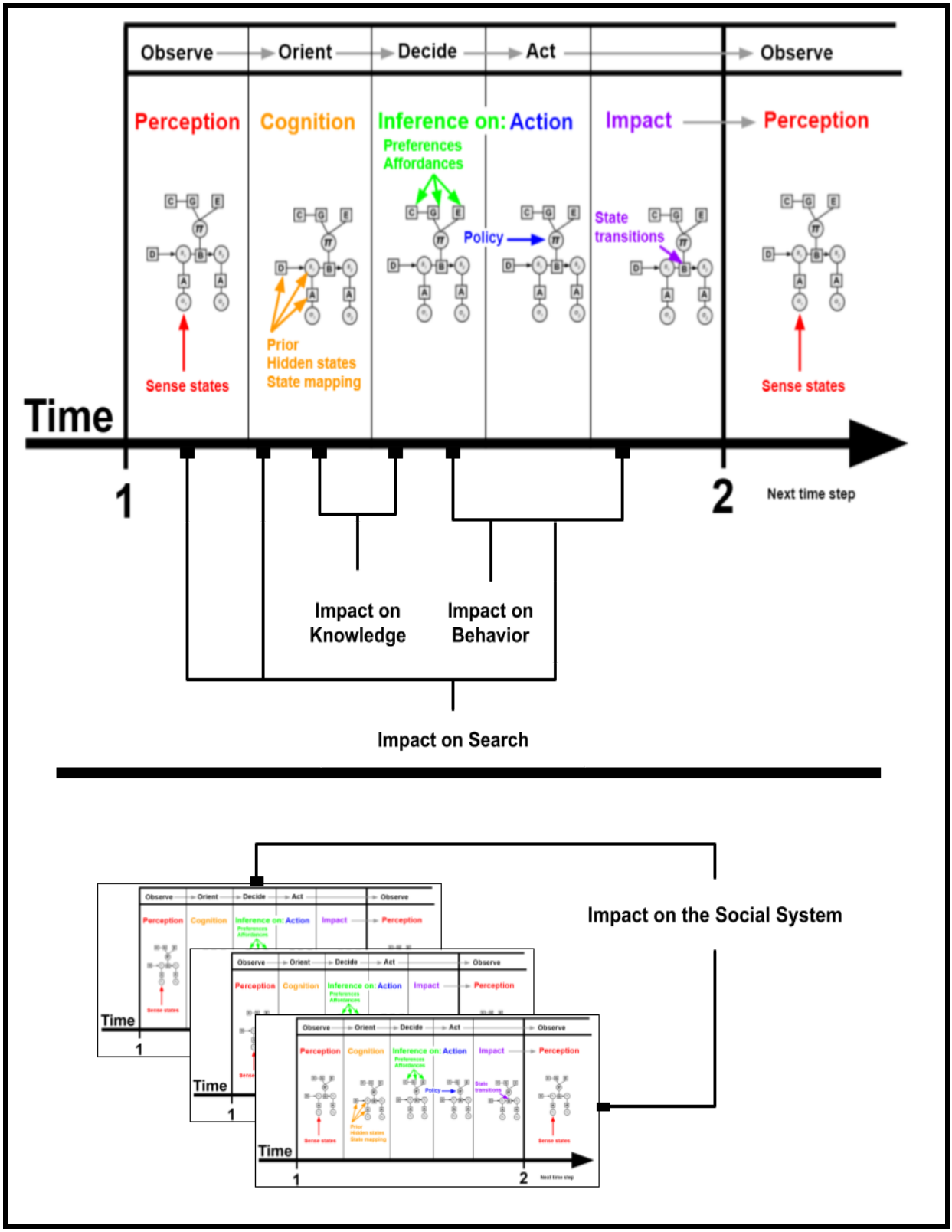

Figure 1. Framing Information Impacts using the Active Inference Action-Perception Loop. Modified from [14].

Defining a Foundation for Determining Value of Impact

Here we propose a set of terms and discuss relevant limitations and assumptions in order to provide a foundation for determining impact of information exposures and interventions.

The following definitions are used throughout this discussion:

> **Collaborative Space.** A collaborative space is here defined as the abstract space wherein 2 or more actors work together to maintain or adjust the status quo of a particular meaning or belief when it is targeted by or is expected to be targeted by some information threat or is subject to some information vulnerability.
>
> **Belief.** A belief here is defined as an expressed or implied claim about the world by an individual or collection of individuals.
>
> **Lens.** A lens here is defined as a cluster of supporting or refuting beliefs, symbols, memes, and other objects relevant to the narrative surrounding some central belief held by an individual or collection of individuals.

The assumptions which underpin and warrant these definitions are as follows:

> **The Information Environment has No Clear Boundaries.** Every human being that is interacting with the internet is affecting that environment in ways that may be aligned or misaligned with the intents of any other actor attempting to manipulate that environment. The use of the term collaborative space is a means to constrain the actors, information, and outcomes of interest.
>
> **Narrative is a Black Box.** Narrative is difficult to articulate and analyse [1]. More concrete alternatives in cognitive modelling are not yet ready for use in real world settings, and may not be for some time. However, a lens represents a package which is useful for qualitative aspects of analysis of information impacts and related decision making, and the use of a central belief as a centre of gravity represents an opportunity to scope analyses.

With these assumptions in mind, we assert that a belief held by an individual can be an asset to a company in much the same way that a brand can be, the value of which can be

approximated using similar models [15,16]. In some ways, this approach may simply be an alternative to valuation some relevant aspects of the brand itself. Moreover, changes from one belief to another (or changes in certainty about those beliefs) in individuals can have calculable profits or losses in the form of value for companies, and the return on advertising expenditure can be calculated with consideration for losses to the value of the brand incurred by accidentally poor messaging.

In a **highly simplified** example, the per annum value of a particular belief, *B*, of an individual to a company might be valued at the probability of a commercial action or set of commercial actions associated with that belief, A_p, multiplied by the average per annum dollar value, *V*, of that action or set of actions to the company, minus the relevant ad expenditure, *E* (see Equation 1); and the P/L of the transition from one belief to another might be simply valued as a function of the difference in the value between those two beliefs (see Equation 2).

$$f(\mathrm{B}) = \mathrm{A_p} \cdot \mathrm{V} - \mathrm{E} \tag{1}$$

$$g(\mathrm{B_1} \rightarrow \mathrm{B_2}) = f(\mathrm{B_2}) - f(\mathrm{B_1}) \tag{2}$$

Real-world implementation would require a significant amount of work for a number of reasons, such as:

> **Determining Status of Belief.** As noted earlier, cognitive status cannot be confirmed - the only available option is to make inferences about the status of belief from relevant data. Large amounts of data may be necessary in order to infer status of belief from interactions with artefacts and claims associated with a lens.
>
> **Social and Cognitive Complexity.** As noted earlier, analysis of effect of isolated inputs or phenomenon in complex systems is highly challenging. Cognitive and social systems present a myriad of factors which exacerbates this difficulty. For example, it may be assumed that human behaviours are consistent with beliefs, but this is not always the case. Moreover, beliefs have numerous determinants and in any given

time period, individuals will be consuming information affecting beliefs which cannot be captured by the observer. Even within a controlled environment, measuring the impact of specific information in context with a lens would be extremely challenging.

Individuals or customers will also have different thresholds for actions given the same belief. For example, one person may be willing to purchase a product if it is reported as only over 80% effective, whereas another would be willing to do this at 50%. Direct interviews and self-reports will be vulnerable to post-hoc reasoning and justification, and further, people make decisions through biassed information and processes which they may not even be aware of. [1]

Accounting for Cost and Potential for Impact. Attempts to influence narrative come in many forms. Even where heavily patterned or categorised, techniques to influence narrative and belief need to be tailored in order to be effective. Techniques would need to be patterned, and numerous case studies would have to be assembled in order to develop composite functions for cost and estimate of impact given parameterized implementation.

Accounting for Risk. Attempts to influence narrative always carry risk of "blowback" and unintended negative consequences. Further, different techniques and use-cases come with their own specific, parameterised risks. In order to acknowledge this risk in calculation of cost estimates, numerous case studies of failed implementations would need to be assembled and analysed.

Accounting for Opportunity Cost. Given varied parameters within patterns of implementation and pattern- and use case-specific risks, comparison of techniques will be challenging. In order to acknowledge opportunity cost, use-cases, techniques, and risks would all have to be well categorised by pattern, and well documented in order to allow development of heuristics and formal methods for classification of new situations and comparison.

[1] For a deeper discussion of this topic, see *Judgement under Uncertainty: Heuristics and Biases,* by Amos Tversky and Daniel Kahneman, and *Psychology of Intelligence Analysis,* by RJ Heuer.

In the face of these challenges, there is the potential to use methods found in auction theory as a means of alleviating, or at least externalising, some of the most complex aspects of measurement, such as determining status of belief or the value of the shift in belief. Auctions can be used as an instrument for purposes other than the exchange of goods; for example, they can be used as an alternative to other systems in order to increase information transparency [17]. Important to our immediate purposes, is that they can be used as a crowdsourced, information processing mechanism to approximate the value of hidden states [18].

Consider, for example, that if a bidding mechanism incentivises a bidder to express their true valuation of the object of the auction within their bid, then the mechanism is considered to be *incentive compatible* within this context [19], and can therefore be implemented to reveal information about the market. Of course, even with incentive compatibility - the bidded value can be considered the valuation of the object by the bidder within a profit-seeking context, as opposed to some objective value of the object itself - as the bidder is expected to seek *profit* from the interaction by bidding underneath what the object might be actually worth to them.

Provided that a small crowd of organisations interested in changing a particular belief can be convened, and that organisations which would provide narrative influence as a service (e.g. small advertising firms) could be convened as well, then auctions might be used to consider the valuation of impact on a belief or the status of belief within demographics through an expression by a willingness to pay, and the costs of particular responses through an expression of willingness to work.

The Vickrey auction is one type of auction which is designed to reveal information about pricing [20,21]. Using a mechanism referred to as a second-price procedure, the auction allows for sealed, single-bid, asynchronous auctions that are isomorphic to synchronous, progressive-bid counterparts. The bidder with the highest price wins the auction, but pays the second-highest bid - allowing a bidder to express their highest and most honest valuation of the object, while simultaneously allowing them to profit from the bid.

Vickrey auctions come with 2 primary drawbacks, vulnerability to impacts of cheating and the potential for reluctance to submit an honest bid. The potential for impacts of cheating are obviously not exclusive to Vickrey and other sealed-bid auctions, however, sealed-bid auctions, as opposed to progressive bid auctions, do not allow bidders the opportunity to exit if the bid behaviour indicates they are being victimised. Furthermore, actual cheating is not necessary to have an outsized effect on the auction quality - the assumption of a positive probability of cheating is enough [21]. In terms of reluctance to submit an honest

bid, a Vickrey auction only produces quality results where honest bids are submitted, and behavioural, cultural, and strategic reasons can affect the bid submitted. For example, the rules of bid may be counterintuitive to bidders; given that a bid is generally understood to be the price you would expect to pay in the case of its success, it may lead some bidders to underbid despite the bidding mechanism's incentive alignment. In addition, if the bids values will be revealed after the auction - there can be strategic concerns associated with giving the true value or true pricing.

Quantifying Cost and Impact of Misinformation and Intervention

If a belief can have value to a company, a belief can also represent an abstract liability. *Misinformation* can be defined **within this context** as information exposures which have impacts on beliefs defined in the collaborative space, such as reinforcement of undesired beliefs or undermining of desired beliefs. Misinformation threats can cause all sorts of economic losses for the firm, such as:

- Reduced sales (e.g., due to rumours about product safety or ethics)
- Fall in price customers are willing to pay (e.g., due to expectations of product longevity or quality)
- Increased cost of production (e.g., employee morale or shortage of applicants)
- Increased cost of capital (e.g., rumours which scare off investors)

A given information threat could theoretically be analysed as to how it might affect a particular shared belief, meaning, or lens, and how that change impacts each determinant of cost and revenue within a composite loss function, retrospectively or in real time. This loss function can then be used to compare and triage information threats, and weigh the cost and risks of various patterned interventions in order to consider response options. As an alternative to complicated cost functions, auction theory may be of use here as well - through the convening of service providers to bid. More work is certainly necessary to consider both the construction of cost functions and the structure of auctions.

Estimating Impact and ROI in Non-Commercial Information Operations

As suggested above, beliefs unrelated to commercial activity do not have a calculable common reference value, which is necessary for acknowledgement of opportunity cost, accounting for risk, and estimating the impact of particular techniques. However, if

techniques, use-cases, risks, responses, and even categories of beliefs themselves are heavily patterned and documented, then ROI for non-commercial related implementations and analyses might be given analogous reference values through extrapolation from their commercial counterparts. In many cases, analogous techniques will not have to be mapped in order for extrapolation. A number of attempts have already been made to pattern narrative influence techniques and risks outside of commercial contexts, for example, the DISARM framework [2] and the Narrative Campaign Field Guide [1], and a large number of these patterns can be used in both commercial or non-commercial contexts.

Developing the Business Case

Regardless of whether or not the frameworks above are used, the convening of organisations exposed to similar information risks for the purposes of information sharing is a necessity in the development of collective tradecraft. To this end, the development of incentives related to a business case, particularly for smaller businesses who would have more to gain from collaboration and information sharing, may be among the most viable options. This is the setting in which trade associations typically form, and in which guilds have formed in the past, to foster information sharing, cultivate standards of practice and legally-recognized collective “duties of care” for the industry, and other information risk mitigations based on the recognition of the risk reducing value of information sharing. In emerging commercial contexts and nascent markets, where collective attention to shared market and risk metrics is insufficiently developed, achieving levels of analytical cohesion that are prerequisites to collaboration is more difficult. Forming such a business case would require attention to a number of factors:

Needs Analysis and Market Making. Without a proper understanding of how relevant organisations understand their information risks and opportunities, it will not be possible to build a market for information and information services exchange.

Tools for Initialising Collaborative Spaces. Proper understanding of the needs and a common set of information risks and opportunities, may allow for organisations to convene, but to ensure they can collaborate, they will need tools to assist in the rapid definition of collaborative spaces in order to build markets (e.g. auctions) around the impact, maintenance, or analysis of particular beliefs. Once defined, collaborative spaces can be tethered to cost and impact estimates to incentivise collaboration between users with similar needs, risks, and

objectives who can de-risk together in ways they could not do alone. Actors will then be drawn into the equivalent of an information "neighbourhood watch," and will have the incentive to collaborate in responding to information threats and sharing best practises when the meaning which is targeted by the information threat is of value to all of the actors involved. For example, beliefs related to airport safety would affect all airports and airlines, as well as a number of government agencies. If modelled as a game, the Nash equilibrium and strong dominant strategy for all actors would be to collaborate.

Narrative Information Management Tools. Strong patterning and categorisation of information threats, risks, use-cases, and practises associated with impact, maintenance, and analysis of beliefs and lenses, as well as for beliefs and lenses themselves, would be necessary in order to abstract particular situations or beliefs such that collaborative spaces can allow for larger numbers of actors. In order to collaboratively develop collective tradecraft, documentation, and patterns, there is a need for common, usable information management tools, standards, and protocols [22]. Further, proper documentation and collection of case studies may allow for the inclusion of historical data in estimation of impact data, though this will come with its own challenges.

Governance Protocols. Organisations are unlikely to share in proprietary or sensitive information without security assurances. Data trusts and protocols for sharing with selective disclosure might be used in order to allow for information sharing.

Clear Value Proposition. The value of participation would have to be communicated effectively. Access to new markets and the ability to monetise extant data may be viable options in the short term, in the absence of the cost and impact estimates (which could only come from repeated interactions and commitments to information sharing).

How to Integrate Non-Commercial Community. One of the most difficult challenges to overcome, may be the integration of the non-commercial communities into extant commercial convenings and workflows. Work would have to be done to understand specific areas of overlap, and where those working on non-commercial use cases can bring specific value to their commercial counterparts.

Conclusion

This white paper explored the potential to estimate cost and impact of information intervention and misinformation, opportunities and their respective challenges. We have also discussed the causal mechanisms through which a more generally defined misinformation can cause economic damages, both through linear and non-linear impacts, and offered some paths and potential methodologies toward quantifying costs, incentivizing and convening organisations for collaboration, and extrapolating estimations of impacts in commercial cases, to their non-commercial counterparts. Although a thorough exploration of the potential to estimate the society-level impacts of misinformation was outside the scope of this document, the foundation to do so was considered while evaluating the potential for cost and impact estimation at the level of the firm. However, this work was exploratory, not exhaustive, and more work is certainly needed. To this end, we offer the following recommendations both for future research and for those building tools and methodology relevant to or adjacent to that work:

Review of the Literature. A more exhaustive literature review is necessary. This review should be performed by an interdisciplinary team with members coming from industry, government and policy space, and academia, as, given lack of conformity to ontology across sectors, there is likely a large amount of literature which would be missed by researchers in any particular field.

Collection of Historical Case Studies. While work has already been done to collect relevant case studies, we are not aware of any exhaustive catalogue or collation of case studies relevant to misinformation or information interventions generally

Explore Potential Collaborative Spaces. More work is necessary to discover what industries may contain organisations which are well suited as models for or beneficiaries of common collaborative spaces. For example, where industries might see misinformation costs as especially high. As an alternative, collaborative spaces might be defined, and evaluated for how many organisations, regardless of industry, would find it to be relevant to their interests.

New Tools for Literature Analysis. As noted, there is a lack of ontological conformity across the relevant literature, new tools are

required to perform searches which move beyond keywords to semantics and relevant subject matter. For example, advertising spending and political campaign spending could be very closely related depending on perspective and community focus. Unfortunately, there is also lack of ontological conformity even within the relevant fields, which means computational ontology may not be an option - instead we recommend that research questions be developed for advancing search methodology which uses crowdsourcing or humans-in-the-loop.

Tools for Integrating Analysis Pipelines. There are a wide variety of tools, analysis techniques, organisations, “data lakes,” and systems relevant to social listening - but there are few means to integrate respective information pipelines with selective disclosure. There is a need for methods to map and translate data between communities while allowing for the ability to monetise, bundle, and restructure. Most difficult among the requirements, is the need to avoid both central repositories and digital twins, as they come with significant challenges regarding governance, storage, and computational expense.

Tools for Inter-Community Narrative Information Management. In addition to the need for new tools for integrating analysis pipelines, there is also a need for tools which allow for effective documentation and evidence collection between communities with effective recourse for handling disagreements. These tools would need to be built to integrate with other systems, and provide affordances for assisting in directing member attention to opportunities and needs within various communities.

Experiment Design and Wargaming. In order to buttress any attempts at estimation, meta-analyses of past empirical research related to information exposure should be conducted or collated and mapped to patterns of practises, risks, and use cases. Further, work on wargames related to narrative influence appears to be limited - given the potential for serious games and wargames to be used for estimation of the real world phenomena and their mechanisms through extrapolation, it is advised that more work be done to explore potential in this space in order to take advantage of the high level of environmental control they can provide.

Research on Applied Cognitive Modelling. There has been a great deal of research on cognitive modelling for decision making in myriad contexts, however, cognitive modelling associated with decision making using narrative and rhetorical compressions in relation to financial costs, was not found during initial exploration of the non-proprietary literature. It is recommended that we find ways to bridge the gaps between political science, economics, advertising, and cognitive modelling to produce non-proprietary research in this area.

Funding and Acknowledgements

R.J. Cordes is funded through the NSF Convergence Accelerator Trust and Authenticity in Communication Systems Program (NSF 21-572), under award ID #49100421C0036 and is supported in research efforts through a Nonresident Fellowship with the Atlantic Council on appointment to the GeoTech Center.

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