Designing Effective Network Visualization Representations of Disinformation Operations – Improving DisInfoVis

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Abstract

Practitioners working to understand, combat, and inform the public about disinformation operations need tools to analyse these complex social phenomena, and communicate their findings to stakeholders. Temporal network visualization presents a means of analysing and communicating this dynamic socio-technical phenomenon, but comes with visualization design challenges that can be addressed through judicious iterative design and empirical evaluation. We present a path towards tailoring temporal network visualizations for DisInfoVis through qualitative evaluation, and outline a design for representing disinformation operations in social media networks informed by this process and used in public communication.

CCS Concepts

• ***Information systems*** → ***Social networks;*** • ***Human-centered computing*** → ***Information visualization;*** *Empirical studies in visualization; Graph drawings;* ***Visualization techniques;*** • ***Security and privacy*** → *Social engineering attacks;*

1. Introduction

Temporal network analysis can expose the evolution of interactions in a data set, but can be confusing to interpret by an untrained eye. This method is particularly useful in disinformation research, where online state-backed information operations are ever-evolving, and are formed by networks of information flows delivered by inauthentic accounts [BH18]. Here we work towards developing effective approaches for such *DisInfoVis*.

» https://gicentre.net/disinfovis

Digital disinformation is an interesting phenomenon to explore through temporal network analysis due to the complexity of the disinformation efforts of some foreign states that have been found to exist and evolve since the inception of their host social media platforms [BH18]. But it can be informative [KP19]. Yet the richness, complexity and dynamism of the temporal networks can result in a data communication problem between those using visualization and the stakeholders they are intended to aid. There are two main ways to represent the temporal dimension of a network visualization [FQ11, MMBd05, BBDW14]. In a *static representation*, selected moments in time are shown in order, with abrupt transitions between them - such as through a slideshow. In a *dynamic representation* a longer sequence of images is presented with smooth transitions - such as through a movie showing the entire time period. Short pauses in such movies can emphasize key moments. Each approach involves inherent benefits and challenges to domain experts trying to interpret evolving interactions in their data.

Network visualizations can be evaluated through task-based quantitative methods [HMB17, RSA*16] and complimentary qualitative approaches. In the first phase of this work we use the latter to explore relationships with data achieved through visualization among expert users working with realistic use-cases [Car08, IZCC08, Zos18]. The visualizations were built from data attributed to Russian, Venezuelan, and Chinese disinformation operations on Twitter [GR18]. Our networks link inauthentic accounts and the hashtags they used through a force-directed layout, with edges coloured according account creation year. Activity is grouped into three-month intervals in both representations, with key moments selected if they displayed a noticeable change in activity, or contained a newsworthy event. We recruited disinformation practitioners to use static and dynamic visualizations of temporal networks to enable us to explore the following research questions:

- **RQ1** *What are the benefits and challenges associated with static and dynamic temporal network visualizations?*
- **RQ2** *What are the unique and shared aspects between state-backed information operations on Twitter?*

Their reactions and responses enabled us to iterate through designs and make recommendations. We used this information to develop designs that explored a subsequent research question:

- **RQ3** *Do these recommendations apply when communicating disinformation operations to the public?*

2. Methods

An evaluative study with "*full datasets, domain specific tasks, and domain experts as participants*" [Car08] was employed in order

to tailor the resulting recommendations and visualizations to the field of disinformation. We recruited five domain experts engaged in understanding, combating, or informing the public about online disinformation via email invitations through a snowball sampling method. The participants undertook training before exploring the visualizations in a simulated analysis session. Participants compared disinformation campaigns and were asked to identify structure, similarities and differences in the operations of the different countries according to the nature of their interactions, the content of their most used hashtags, and the temporal evolution of their operations. They then provided qualitative feedback through structured interviews. Transcription and thematic analysis [BC06] grouped responses into *themes* in light of benefits and challenges, faced while using the visualizations, recommendations made for future visualizations, and analysis of the networks themselves.

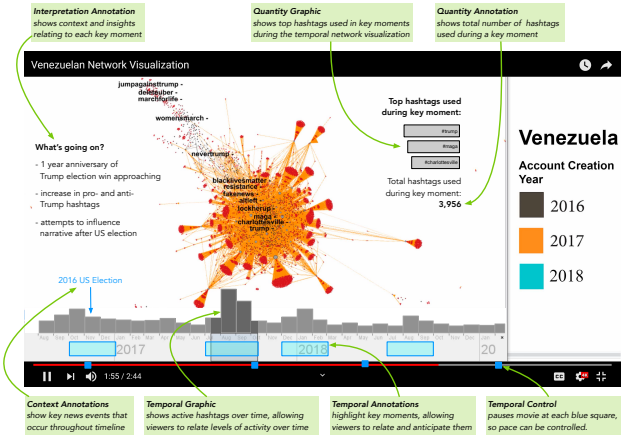

Figure 1: *Proposed wire-frame for a temporal network visualization that contains static and dynamic elements. Themes are* ***bold****.*

3. Results

RQ1 – participants found the dynamic representations most effective, as every participant stated that the dynamic videos gave them a better understanding of the evolution of the networks over time. Although participants liked moving through the static slideshows at their own pace, four out of five appreciated some dynamism for analysing the networks or explaining them to others. In terms of the design differences, temporal resolution and continuity (video) were favoured over temporal selection and control (slideshow), but the content analysis made it clear that our participants considered control to be an important factor in understanding the evolution of the networks. The importance of interpretative statements to provide context was also apparent. A proposed wire-frame for an improved representation that accommodates some of these characteristics is outlined in Fig. 1. During the simulated analysis session that addressed **RQ2**, participants noted that disinformation operations are cyclical, dynamic, and evolve over time. They also found that some operations appeared to be more organized and political than others, and that the Russian activity was uniquely exhibiting polarization in its network structure. Both Russia and China were found to be resurrecting old accounts from as far back as 2009 and redeploying them in politically motivated sub-operations in 2016 and 2019. These behaviours suggest that actions are part of long-term strategies, and their detection validates our setting to an extent.

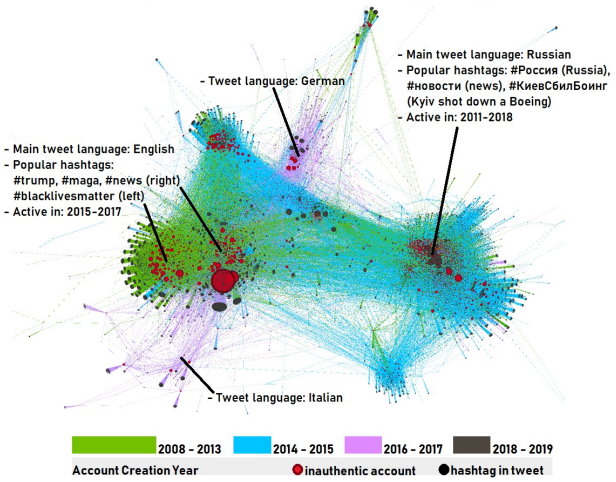

Figure 2: *Static network visualization of entire campaign for Russia (Internet Research Agency) data. Annotations show tweet language, popular hashtags, and activity dates for distinct regions.*

4. Representations for Reporting

Our work on **RQ1** informed designs for *DisInfoVis* developed to explore **RQ3**. Based upon analysis of six data sets on state-backed disinformation operations on Twitter [GR18] they were disseminated in a Medium article [Pav20] (Fig. 2). Networks for each country are accompanied by contextual graphics including a bar chart of tweet volume over time, captions containing tweet language, popular hashtags, and activity dates of distinct network regions, and a video of the network evolving over time. Short paragraphs of analysis are also provided for context. The complimentary coordinated views and explanations were designed to provide the levels of detail, temporal continuity, control and context identified as important factors in informing understanding in phase one.

5. Reactions

The phase two representations have received positive feedback from the public, presently accruing just under 100k views and 10k reads, but formal evaluation to understand the impact of visualization design choices on public understanding has not yet taken place.

6. Conclusion

In this poster, initial designs of temporal network visualizations of disinformation operations were introduced, and evaluated by disinformation practitioners in qualitative interviews. Participants found that they preferred designs that have both dynamic and static elements - wanting detail, annotation for context and control in network representations of disinformation operations to help them compare and understand the strategies used in these operations. The second phase of this research is ongoing and involves a temporal network analysis of six disinformation operations. The visualizations communicated to the public contained both static and dynamic elements, and contextual information and have been widely viewed. In further research, structures that recur in different disinformation operations, as identified through our network visualization representations, will be distilled into a taxonomy and communicated through further designs for *DisInfoVis*.

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