Misinformation in the loop: the emergence of narratives in Online Social Networks

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Abstract. The interlink between information and belief formation and revision is a fundamental aspect of social dynamics. The growth of knowledge fostered by a hyper-connected world together with the unprecedented acceleration of scientific progress has exposed individuals, governments and countries to an increasing level of complexity to explain reality and its phenomena. Despite the enthusiastic rhetoric about the so called *collective intelligence*, conspiracy theories and other unsubstantiated claims find on the Web a natural medium for their diffusion. Cases in which these kinds of false information are used in political debates are far from unimaginable. In this work, we study the behavior of users supporting different (and opposite) worldviews – i.e. scientific and conspiracist thinking – that commented the posts of the Facebook page of a large italian political party that advocates direct democracy and e-Participation. We find that users supporting different narratives consume political information in a similar way. Moreover, by analyzing the composition of users active on the page in terms of commenting activity, we notice that almost one fifth of them is represented by polarized consumers of conspiracy stories, and those are able to generate almost one third of total comments to the posts of the page.
Keywords: misinformation, collective narratives, crowd dynamics, information spreading.

1 Introduction

In the past few years an impressive research effort has been devoted to definition of theoretical and pragmatical implications of e-Participation [1–6]. However, not much is known about the peculiarity of users content selection when dealing with critical issues such as collective decisions. The Web has become pervasive and digital technology permeates every aspect of daily life. Social interaction, healthcare activity, political engagement and economic decision-making are influenced by digital hyper-connectivity – i.e. the increasing and exponential rate at which people, processes and data become connected [7–14]. In particular, people perceptions, knowledge, beliefs, and opinions about the world and its evolution

get (in)formed and modulated through the information they can access, most of which coming from newspapers, television, and, more recently, the Internet – where the passage from hierarchical information structures (one to many) to complex networks (many to many) changed information spreading patterns. Nowadays, everyone can produce and access a variety of information actively participating in the diffusion and reinforcement of narratives. Such a process has been enthusiastically dubbed as *collective intelligence* [15, 16], and this kind of disintermediation had a profound impact on individuals, governments and countries, by offering huge social and economic gains and, at the same time, presenting new governance and assurance challenges [17–24]. Despite the enthusiastic rhetoric about the ways in which digital technologies have burst the interest in debating political or social relevant issues, and the obvious and well-documented benefits of a hyper-connected world – the role of the World Wide Web in enforcing informed debates and their effects on the public opinion still remain unclear, and the rapid viral spread of information that is either intentionally or unintentionally misleading or provocative could have serious consequences. For these reasons, the World Economic Forum listed *massive digital misinformation* as one of the main risks for the modern society [25]. The increasing growth of knowledge fostered by a hyper-connected world together with the unprecedented acceleration of the scientific progress has exposed society to an increasing level of complexity to explain reality and its phenomena. In fact, conspiracy theories as alternative explanations to complex phenomena (e.g. globalization) find on the Web a natural medium for their dissemination and, not rarely, they are used as argumentation for policy making and foment collective debates. Conspiracists tend to reduce the complexity of reality by explaining significant social or political aspects as plots conceived by powerful individuals or organizations. As these kinds of arguments can sometimes involve the rejection of science, alternative explanations are invoked to replace the scientific evidence. For instance, people who reject the link between HIV and AIDS generally believe that AIDS was created by the U.S. Government to control the African American population [26]. Cases in which these kinds of false information feed into an existing worldview, making it harder to dislodge, are far from unimaginable – especially in online social networks where information is less publicly visible, like friends' networks or communities supporting specific narratives on Facebook. The spread of misinformation in such trusted networks can be particularly difficult to correct [27–30]. Since unsubstantiated claims are proliferating over the Internet, what would happen if they were used as the basis for policy making? What would happen if the discussion about critical issues such as vaccination or economic strategies were grounded over incorrect or false information? Moreover, while it is certainly possible for unsubstantiated claims to spread accidentally, it is also possible for misinformation to be deliberately propagated by those who stand to reap some kind of benefit. Such a scenario makes crucial the quantitative understanding (and beyond pure speculation or experiment on small groups) of the relationships within content selection, information consumption, and beliefs formation and revision. In fact, a recent work [31] showed that on the web

unsubstantiated claims reverberate as long as other kind of information and in [32] the authors have studied the consumption patterns on Facebook of 1.2 million of individuals supporting different (and opposite) worldviews – i.e. scientific and conspiracist thinking – confirming the hypothesis of *cognitive closure* for conspiracists, i.e. their attitude to avoid profound scrutiny of evidence in front a given matter of fact. Moreover, in the same study, it has been analyzed the response of the social system to 4,709 intentional false claims with a satirical taste, finding that users mainly consuming conspiracist news are the one more prone to respond with a positive feedback. In this work, we provide an extension of the previous mentioned studies by analyzing the consumption patterns of 1.2 million of individuals on the Facebook page of a large italian political party that advocates direct democracy and e-Participation, for which we downloaded all the posts and the related users' interactions for a timespan of 4 years (2010 to 2014). In particular, we first aim at confirming that users supporting different (and opposite) narratives consume politics-related information in a similar way; we then study the composition of users and their commenting activity on the political page. We show that a large number of users interacting with the online political movement is composed by users that usually consume conspiracist news, which has been shown to be less critical in diffusing false information [31]. Such a result raises a warning about the current practices to be addressed for the e-Participation research.

2 Data Collection

The debate around relevant social issues spreads and persists over the Web, leading to the emergence of unprecedented social phenomena such as the massive recruitment of people around common interests, ideas or political visions. We defined the space of our investigation with the help of Facebook groups very active in the debunking of conspiracy theses. The resulting dataset is composed of 73 public pages categorized in scientific and conspiracist news for which we downloaded all the posts (and their respective users' interactions) for a timespan of 4 years (2010 to 2014). The exact breakdown of the data is presented in Table 1. The first category includes all pages diffusing conspiracist and alternative information – pages which disseminate controversial information, most often lacking supporting evidence and sometimes contradictory of the official news. The second category is that of scientific dissemination including scientific institutions and scientific press having the main mission to diffuse scientific knowledge. Notice that it is not our intention claiming that conspiracist and alternative information are necessarily false. Our focus is on how communities formed around different information and worldviews consume information. We focus our analysis on the interaction of users with the public posts – i.e. likes, shares, and comments. Each of these actions has a particular meaning. A *like* stands for a positive feedback to the post; a *share* expresses the will to increase the visibility of a given information; and *comment* is the way in which online col-

lective debates take form. Comments may contain negative or positive feedbacks with respect to the post.

	Total	**Science**	**Conspiracy**
Pages	73	34	39
Posts	271,296	62,705	208,591
Likes	9,164,781	2,505,399	6,659,382
Comments	1,017,509	180,918	836,591
Commenters	279,972	53,438	226,534
Likers	1,196,404	332,357	864,047

Table 1. Breakdown of Facebook dataset. The number of pages, posts, comments, and likes for scientific and conspiracist pages.

3 Results and Discussion

3.1 Different narratives, consumption patterns and polarized users

Fruition of contents related to different (and opposite) narratives – i.e. scientific and conspiracy thinking – has been investigated on a sample of 1.2 million of individuals consuming information in a timespan of 4 years by liking, commenting, and sharing posts of Facebook pages supporting different worldviews [32]. Figure 1 shows the empirical Complementary Cumulative Distribution Function (CCDF)[5] for *likes*, that in the vast majority of the times are intended as positive feedbacks to the posts; *comments*, the way in which online collective debates take form; and *shares*, intended as the will to increase the visibility of a given information. In spite of the diverse nature of the information, posts are consumed in a similar way.

[5] We remind that the CCDF of a random variable X is the function $f(x) = \mathbf{Pr}(X > x)$.

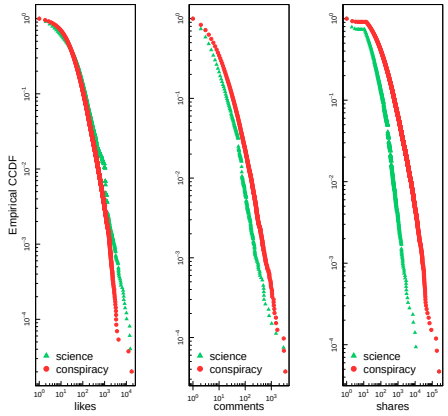

Fig. 1. Consumption patterns. Empirical Complementary Cumulative Distribution Function (CCDF) of users' activities (likes, comments and shares) on posts grouped by page category. The distributions are indicating similar consumption patterns for pages supporting different worldviews.

However, by a correlation analysis on the combinations of interactions it has been shown that posts on conspiracy pages are more likely to receive likes and shares. Such a result indicates a strong attitude of conspiracy users toward dissemination.

To identify communities and their consumption patterns with respect to the information both in favor and against their system of beliefs, users have been labeled as *polarized* in one community or the other through a simple thresholding algorithm. In particular, a user has been defined as *polarized in science* if more than 95% of his/her likes were on posts of pages supporting scientific thinking; conversely, a user has been defined as *polarized in conspiracy* if more than 95% of his/her likes were on posts of pages supporting conspiracist thinking.

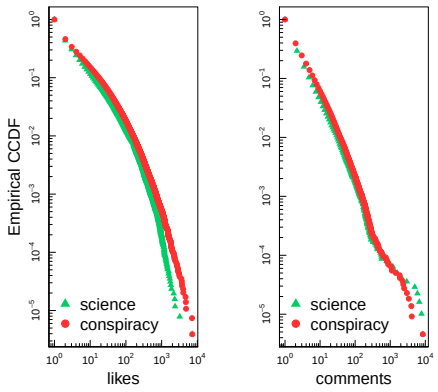

Fig. 2. Consumption patterns of polarized users. Empirical Complementary Cumulative Distribution Function (CCDF) of polarized users' activities (likes and comments). Both distributions are indicating similar consumption patterns for users polarized in different communities.

The thresholding algorithm labeled 255,225 users polarized in science and 790,899 users polarized in conspiracy. By looking at the commenting activity of polarized users both inside and outside their community, we find that users polarized in conspiracy tend to interact mainly in their community both in terms of comments and likes; conversely, users polarized in science appear to act slightly more outside their community. Furthermore, despite the diverse nature of the information, consumption patterns by users polarized in different communities are similar. Figure 2 shows that the interaction with posts by users polarized in different communities is quite similar both in terms of likes and comments.

3.2 Narratives and credulity

In [31] it has been shown that users who engage with debates on posts of conspiracist pages are much more likely to engage with debates on posts of intentional false news posted by troll pages – i.e. satirical and paradoxical imitations of conspiracist information sources.

One of the most popular memes that spreads an intentional false information reads (in text form): *Italian Senate voted and accepted (257 in favor and 165 abstentions) a law proposed by Senator Cirenga aimed at funding with 134 billion Euros the policy-makers to find a job in case of defeat in the political competition.* This meme contains at least four false statements: the name of the senator, the total number of votes (higher than possible), the amount of money (more than 10% of Italian GDP), and the law itself. It was created by a troll page and, on the wave of public discontent against italian policy-makers, quickly became viral, obtaining about 35,000 shares in less than one month. Shortly thereafter,

the image was downloaded and reposted (with the addition of a commentary) by a page describing itself as being focused on political debate. Nowadays, this meme is among the arguments used by protesters manifesting in several Italian cities.

In [32] the authors have stressed out the critical aspect of contents fruition on Facebook – i.e. how the credulity on online social networks fosters misinformation diffusion – by investigating the way in which polarized users of different (and opposite) narratives interacted with 4,709 intentional false information – e.g. the undisclosed news that infinite energy has been finally discovered, or that a new lamp made of actinides (plutonium and uranium) might solve problems of energy gathering with less impact on the environment, or that a chemical analysis revealed that chem-trails contains sildenafil citratum (the active component of Viagra^{TM}).

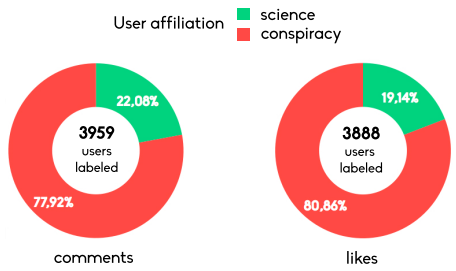

Fig. 3. Polarized users on intentional false information. Percentage of likes and comments by polarized users of the two communities on intentional false information posted by a troll page – i.e. a caricatural and satirical version of a conspiracist page. Users polarized in science aim at inhibiting the diffusion of false claims through their commenting activity, whereas users polarized in conspiracy aim at liking (approving) what *manipulated* main stream information sources are neglecting.

Figure 3 shows the percentage of likes and comments by polarized users of the two communities on intentional false memes posted by a troll page – i.e. a caricatural and satirical version of a conspiracist page. Polarized users of both categories retain their consumption patterns. Users polarized in conspiracist pages are more active in liking and commenting.

3.3 Narratives and online political activism

Here we analyze the interaction of polarized users with politics-related information on Facebook. We look at the interaction with posts published on the Facebook page of a large italian political political movement that advocates direct democracy and e-Participation as the new paradigm for policy making. This movement supports anti-particracy and promotes the direct participation of citizens in the management of public affairs through forms of digital democracy, describing itself as *a democratic encounter outside of party and associative ties and without the mediation of directive or representational organisms, recognizing to all users of the Internet the role of government and direction that is normally attributed to a few* [33].

We downloaded all the posts (15,628) and the related comments (3,140,573) in a timespan of 4 years (2010 to 2014).

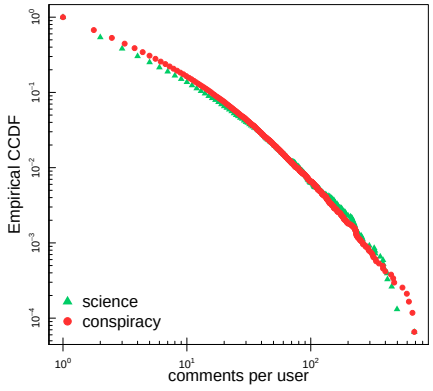

Fig. 4. Commenting activity of polarized users. Empirical Complementary Cumulative Distribution Function (CCDF) of comments on the political page by users polarized in science and conspiracy. The distributions are indicating a similar commenting activity for users polarized in different communities.

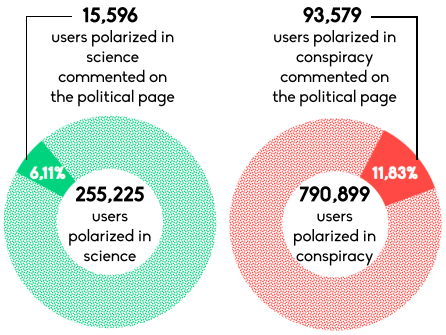

Fig. 5. Polarized users and politics. Percentage of users polarized in science and conspiracy that commented on the political page. Users polarized in science that commented on the political page were 15,596 (6.11%), whereas users polarized in conspiracy that interacted with the political page in terms of comments were 93,579 (11.83%) – i.e., in terms of commenting activity, users polarized in conspiracy are almost twice active than users polarized in science.

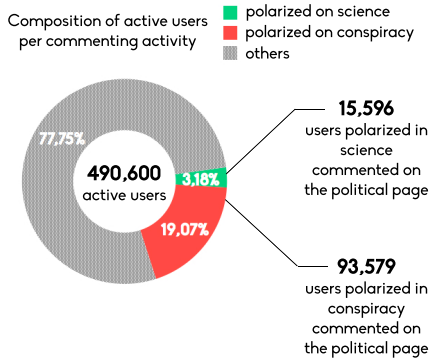

Fig. 6. Composition of active users per commenting activity. Percentage of users polarized in the two communities – i.e. scientific and conspiracist thinking – that are active, in terms of commenting activity, on the Facebook page of a large italian political party that advocates direct democracy and e-Participation. We notice that almost one fifth (19.07%) of the active users per commenting activity is represented by users polarized in conspiracy.

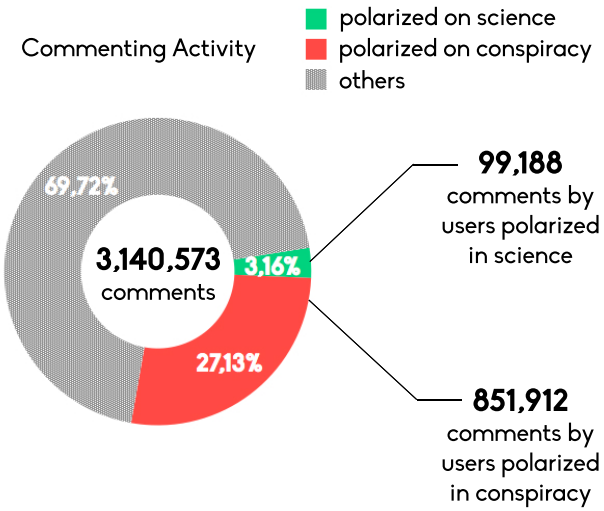

Fig. 7. Commenting activity of polarized users. Percentage of comments by users polarized in the two communities – i.e. scientific and conspiracist thinking – on the Facebook page of a large italian political party that advocates direct democracy and e-Participation. We notice that almost one third (27.13%) of total comments comes from users polarized in conspiracy.

Figure 4 shows the empirical Complementary Cumulative Distribution Function (CCDF) of comments on the political page by users polarized in science and conspiracy. The distributions are indicating a similar commenting activity for users supporting different (and opposite) narratives. Such a result confirms the findings of [32].

Figure 5 shows the percentage of users polarized in science and conspiracy that commented on the political page. We notice that 15,596 users polarized in science (6.11%) commented on the political page, whereas users polarized in conspiracy that interacted with the political page in terms of comments are 93,579 (11.83%) – i.e., in terms of commenting activity, users polarized in conspiracy are almost twice active than users polarized in science.

Figure 6 shows the composition of users active on the political page. We are able to identify 490,600 active users per commenting activity, whereof 15,596 (3.18%) are users polarized in science and 93,579 (19.07%) are users polarized in conspiracy. In other words, almost one fifth of active users per commenting activity on the Facebook page of a large italian political party that advocates direct democracy and e-Participation is represented by users polarized on conspiracy – i.e. those users that are more inclined to engage with debates and

like (approve) posts raising concern on intentional false information. Figure 7 shows the composition of comments on the political page. Total comments are 3,140,573, whereof 99,188 (3.16%) are from users polarized in science and 851,912 (27.13%) are from users polarized in conspiracy. Such a result is indicating that almost one third of comments (the way in which online collective debates take form) on the Facebook page of a large italian political party comes from users polarized in conspiracy – i.e. those users that are more likely to comment and like (approve) unsubstantiated claims and posts raising concern on intentional false information with a satirical taste.

4 Conclusions

A recent work [31] has shown that on the web unsubstantiated claims reverberate as long as those grounded on more verified information, and that usual consumers of conspiracy theories are more prone to jump the credulity barrier. In particular, conspiracy theories find on the web a natural medium for their diffusion and, not rarely, trigger collective counter-conspirational actions. Narratives grounded on conspiracy theories tend to reduce the complexity of reality and are able to contain the uncertainty they generate. Along this path, in [32] it has been studied how 1.2 million of Facebook users consume information related to different (and opposite) narratives – i.e. scientific and conspiracist thinking. In particular, after having labeled users as *polarized in science* and *polarized in conspiracy* by means of a thresholding algorithm, it has been shown that users polarized in conspiracy are more focused on posts of their community and more committed to the diffusion of news supporting their narratives, whereas users polarized in science are more likely to comment on posts of the opposite community. Such a social dynamics is likely to be led by socio-cognitive reasons. Conspiracists want to diffuse those information that are neglected by main stream sources, whereas users supporting scientific thinking aim at inhibiting the diffusion of unsubstantiated claims and the proliferation of narratives based on conspiracy theories. Moreover, it has been shown how polarized users of both categories responded to the inoculation of 924 intentional false claims with a satirical taste, finding that users of both categories seem to not distinguish the false nature of those information, with users polarized in conspiracy more focused on liking (approving) and users polarized in science more active on commenting (debating). In this work we extend the previous studies by investigating how users polarized in both communities consume political news. In particular, we analyze the consumption by users polarized in science and conspiracy of the posts on the Facebook page of a large italian political party that advocates direct democracy and e-Participation, for which we collect all the posts and the related comments for a timespan of 4 years (2010 to 2014). We first show that users supporting different (and opposite) narratives have similar consumption patterns – by pointing out a comparable commenting activity for users polarized in science and conspiracy. Then, through a quantitative analysis on the comments to the posts of the political page under investigation, we show that users polarized in

conspiracy are a representative fraction of the political discussion in that page. Moreover, by analyzing the composition of the users active on the political page in terms of comments, we find that almost one fifth (19.07%) of total active users is represented by users polarized in conspiracy – i.e. the users that have been shown to be more likely to jump the credulity barrier once exposed to false information. Those users polarized in conspiracy that were active on the political page were able to generate almost one third (27.13%) of total comments. What would happen if candidates for the parliament were selected through a procedure of online voting which selects among online activists?

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