1. *From cyberculture to networked emotions*

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Abstract

An archaeology of computer-mediated communication has to identify the period of popularization of the Internet, in the last decade of the last century, as a crucial moment in the formation of a cyber-political ideology that has guided many of the practices and discourses associated with digital networks. We will review this type of discourse, showing how it became even more widespread when we began to understand that the new digital media are networks in the precise sense of that term. The theory of networks allows us to see how imitation has become increasingly present in the new media, particularly in the most recent social networks such as YouTube, Facebook or Instagram. We will analyse several mechanisms of propagation of imitation, giving particular relevance to the way in which emotions, namely negative emotions such as anger or fear, spread and become dominant in networks. We show empirical data that support that kind of analysis, but we will mainly stress the role that algorithms such as those by Facebook and YouTube play in emotional contagion. This will allow to revaluate the ideas that accompanied the initial phases of the development of the Internet, as well as the dilemmas that the regulation of this network currently faces.

0. Introduction

In a popular book initially published in 1950, called *The Human Use of Human Beings – Cybernetics and Society* (Wiener, 1989), Norbert Wiener, one of the founders of cybernetics, presented a set of ideas that would prove to be important in the creation and development of computer networks. These ideas express an ideology of communication that has its foundation in what was then called symbolic information processing machines, that is, computers. In this ideology, machines should contribute to the implementation of a "communicative ideal". For Wiener, this ideal is based on the fact that "speech is the greatest interest and most distinctive achievement of man" (Wiener, 1989: 85), because "in man, unlike the apes, the impulse to use some sort of language is overwhelming" (ibid.: 83). Still more important, "there is an irresistible trend towards communication". Communication barriers were to be eliminated as far as possible, and this was a task in which these new machines could play an important role. This had already happened with previous means of communication such as the telegraph and the telephone (ibid.: 91), but now, thanks to the new information processing machines, we would be able to "to participate in a continuous stream of influences from the outer world and [act] on the outer world", because "to be alive to what is happening in the world, means to participate in a continual development of knowledge and its unhampered exchange" through a vast worldwide communications system (ibid.: 122).

The combination of communication with the principles of cybernetics should also shape the very architecture of society, which must be a self-regulating system based on the cybernetic principle of feedback. Thus, any management activity must be "two-way", going down and back to the decision manager (ibid.: 165). In general, rigidly hierarchical models create obstacles to communication, which is something to be avoided. For example, "most of us in the United States prefer to live in a moderately loose social community, in which the blocks to communication among individuals and classes are not too great" (ibid.: 50). In short, technological progress is achieved by creating technologies that respond to the "irresistible tendency towards communication" shared by everyone; furthermore, these technologies must be open, and as far as possible must not be hierarchically structured. The "opening of the communication channels" involves a positive ethical judgment, from which follows the now widespread ideology in which communication is, essentially, *good*.

Wiener was one of the first authors to combine communication with technological optimism. His ideas also had practical consequences due to his influence on Joseph Licklider, who was one of the creators of the first computer network, the ARPANET, a precursor of the Internet. Licklider was inspired by the aspects of Wiener's thought that considered computers as communication tools. Whereas Wiener still conceived computers mainly as symbolic information machines, for Licklider the communicative perspective became dominant, and he now had an instrument that made it possible to realise a communicative ideal such as that envisaged by Wiener. He implemented the idea, totally revolutionary at the time, of networked computers. Communication was therefore to be the fundamental objective of the construction of the new medium. Licklider even advanced the idea that the new medium based on networked computers would allow interacting individuals to be communicatively active.

We believe that communicators have to do something nontrivial with the information they send and receive. And we believe that we are entering a technological age in which we will be able to interact with the richness of living information—not merely in the passive way that we have become accustomed to using books and libraries, but as active participants in an ongoing process, bringing something to it through our interaction with it, and not simply receiving something from it by our connection to it (Licklider and Taylor, 1968).

The new technology of networked computers would thus fulfil the ideal of communicatively active individuals. It would be an emancipatory technology, and in fact, for both Licklider and Wiener, it would be "technological progress will save humanity" (Hafner and Mathew, 1996, 34). It is an idea whose novelty should not be underestimated, since it has always accompanied subsequent developments of the Internet.

Wiener's and Licklider ideas were an essential, if not the only, factor in the implementation and development of the ARPANET and the Internet. We will not review here how they inspired the discourse of the counterculture movement, which during the seventies and

eighties also focused on the role that networked computers should play in society (cf. Turner, 2006). Counterculture was at the root of the cyberculture movement that emerged when the Internet became popular in the nineties. This movement also emerged in the context of a network that had evolved without any government regulation, an aspect which was, and still is, regarded as positive. Furthermore, it was also thought that "due to its global reach and decentralized design [the Internet] cannot be monitored" (cf. Gilmore, 1995). The Internet "shakes up all our centralist notions, and hierarchy goes away by example" (Negroponte, 1997). Other authors argued that government would be made obsolete by 'clicking buttons', i.e. by the interactive democracy that an open platform can create (Dyson, 1995). A particularly important text from a cyberculture perspective was the "Declaration of the Independence of Cyberspace", which was signed by John Perry Barlow in 1996.[1] According to this Declaration, cyberspace was to be a unique space that would require a new type of social contract, completely unlike that of modern democratic societies: one based on pure communicative exchanges between individuals. It would be a new type of space in which free individuals linked to each other would self-regulate, and from which a spontaneous, just and transparent order would emerge. As the Electronic Frontier Foundation, founded by Barlow, stressed at the time, "online communities should have the right to establish their own standards". In general, this organisation advocated an open platform model that would form a global communication infrastructure and would provide non-discriminatory access, based on open, private standards, and free from asphyxiating regulation.[2]

Computer networks would make it possible to advance the trend of modernity that since Alexis de Tocqueville has been called "the equality of conditions". This would be possible because cyberspace is solely formed of information, in the sense that it is truly *disembodied* information, without direct physical interaction between individuals. For cyberculture, this could have decisive consequences. It would generate the possibility of what might be called a kind of pure communication, in the sense that completely disembodied communication does not suffer from the innumerable constraints that are inherent in communication accompanied by the visible marks that distinguish and differentiate individuals. One of the great theorists of computer networks during the nineties, H. Rheingold, was clear on this point:

Because we cannot see one another, we are unable to form prejudices about others before we read what they have to say: Race, gender, age, national origin and physical appearance are not apparent unless a person wants to make such characteristics public. (Rheingold, 1996: 422).

1 Available at: https://www.eff.org/cyberspace-independence.

2 Cf. the declaration at: https://www.eff.org/effector/6/5.

In the absence of face-to-face communication, computer-mediated communication would eliminate the social constraints and markers that typically exist in communication conveyed by other means. It would help to eliminate the exclusion of the excluded, and Rheingold even goes so far as to say that the communicative difficulties with the telephone would miraculously disappear if the medium used was computer-mediated communication. There would be a communication between free and equal individuals, thus realising the ideal of a rational public space for discussion.

How should we evaluate this type of discourse in the light of the development of digital networks over the last two decades? There was a time when the "new social contract" based on communicative transparency was deemed "utopian", but the truth is that the lack of regulation and the idea that technology should accelerate communication were important boosters of the development of the networks that have been created in recent years. Was the ideal of the Internet pioneers realised? We carry out an evaluation of cyberculture ideas with a focus on two moments in the evolution of the Internet: we analyse the WWW and the first social networks, and then look at the most recent issues raised by networks such as Facebook.

1. The World Wide Web and the first social networks

The WWW was created by Tim Berners Lee around 1991. His revolutionary idea was to build a new universal media of communication: a universal networked media. We recall that, in general terms, a network can be defined as a set of nodes, n, connected by links (also called edges); a node has also a degree, k, which is the number of links of each node. An important property of networks is the distribution function, $P(k)$, of the links between the nodes. It is relatively intuitive that in a network with a fixed number of nodes, and where the connections between the nodes are created randomly, the distribution function is a normal function (a Poisson or Gaussian distribution); that is, any node has, on average, the same number of links as any other node. In the case of the WWW, the nodes are the web pages, which are linked to each other by hyperlinks. Contrary to expectations, it was found by the end of last century (Albert et al., 1999

) that the distribution function, $P(k)$, of the k hyperlinks between the nodes (web pages) has the form $P(k) \sim k^{-\lambda}$, i.e. a distribution without a characteristic scale, or a power law. In general terms, this means that the probability that a randomly chosen node (page) receives k links decreases according to the ratio given by the exponent λ. The following figure illustrates a power law.

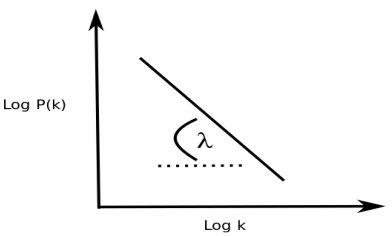

Figure 1. A power law. The probability of a randomly chosen node having degree ***k*** decays as a power of ***k***, where the exponent λ (typically in the range $2 < \lambda < 3$) determines the rate of decay.

In intuitive terms, this means that there are a few pages that receive a large number of links, and a large number of pages that receive few links. That is, the majority of nodes have a degree that is lower than the average, and a small fraction of "big" nodes (hubs) are many times more connected than the average. This distribution is rather different from a normal (Gaussian) distribution, in which the number of links is the same, on average, for all pages. Figure 2 compares a network with a normal distribution versus one without a characteristic scale. Nodes with high numbers of connections (hubs) are shown in grey.

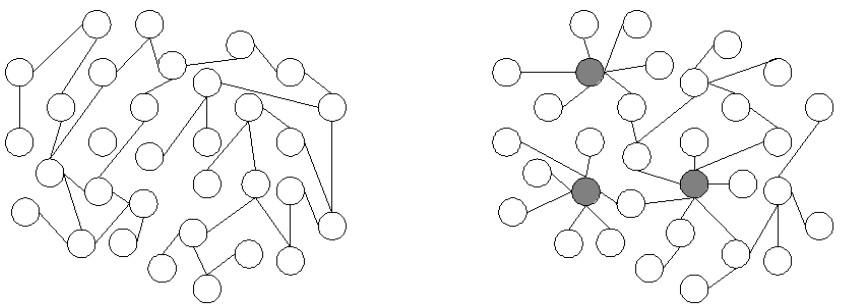

Figure 2. On the left, a random network with a normal distribution; on the right, a power-law distribution network. Hubs are shown in grey.

The invariant final state, the power law distribution *P(k)*, does not emerge from individual acts of creating web pages independently of other identical acts, but instead from interactions between those acts. The mechanism underlying a power law is that the more links a page already receives (i.e. how visible or popular it is), the more it will receive (i.e. the more popular it will become). On the WWW, "popularity is attractive" (Dorogovtsev, Mendes, 2003: 25); that is, popularity begets popularity. Links are created according to previously created links, and if there are numerous links pointing to a certain node, this must be because the node has received a cumulative number of links over time. This mechanism cannot be based on a random linking of pages, and there must be an evolutionary process that generates interactions between nodes. This is an *imitation process*, in which new nodes link to already existing nodes as a function of the previous numbers of connections of these nodes (Barabási et al., 1999). In the WWW, we find not an egalitarian structure, but a pronounced asymmetry between individuals (web sites) caused by their interactions (imitation).

This kind of asymmetry in the popularity of or attention paid to each individual (as measured by the number of links) can be found in all digital networks developed after the

creation of the WWW, such as MySpace, Facebook, Youtube, Twitter, Flickr and Digg, among many others. Originally, these were virtual social networks of "friends", in which based on the definition of a profile, each member invites other "friends" and begins to form a network of links with them. Each "friend" is a node that provides, sends and receives often enormous amounts of content to and from other "friends". As is well known, in addition to friendship relationships, these social networks later introduced other forms of social interaction such as "follow", "like", "share", "comment", etc. It is clear that most of these forms refer to imitation, i.e. to intersubjective relations. They also refer to *desire*—the desire to be the object of others' attention. As a matter of fact, networks such Facebook are programmed to create the conditions for the free propagation of this kind of desire, which is a very different function from the communicative function that cyberculture attributed to the original Internet.[3]

In digital social networks, we have on the one hand a very peculiar spatial structure, given by the distribution function $P(k)$, and on the other hand the manifestation of intersubjective desire. Is it possible to connect these two aspects? If this is the case, then it is desire, rather than disembodied and impersonal communication, that drives the evolution of networked digital media.

A demonstration that desire originates power law distributions was presented several years ago (Huberman et al., 2009), based on studies of YouTube, Twitter and Digg, a platform that aggregates links posted by users. As expected, it was found that the number of contributions made by each producer/user of content on these platforms follows a

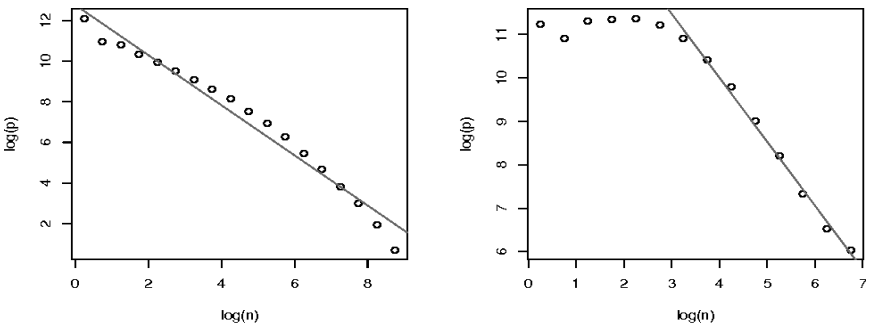

Figure 3. Distribution of the number of contributions to Digg (left) and YouTube (right). The number of contributions follows a power-law distribution on Digg and (with a long tail) on YouTube. Source: Huberman et al., 2009.

More importantly, it was found empirically that there was a *positive correlation* between the number of content contributions to the platform made by each individual (the

3 For instance, Facebook's founding president Sean Parker was also very clear about the intended design of the network from its outset: "it's a social-validation feedback loop … exactly the kind of thing that a hacker like myself would come up with, because you're exploiting a vulnerability in human psychology." Ex-Facebook president Sean Parker: Site made to exploit human 'vulnerability'. (2017, November 9). *The Guardian.* Available at: https://www.theguardian.com/technology/2017/nov/09/facebook-sean-parker-vulnerability-brain-psychology.

productivity) and the *popularity* (attention as measured by the number of "views", "diggs", "likes", "subscribes"), that is, the number of contributions increases with the popularity of the content published by each contributor. The authors of the study then hypothesised that the attention received by each contributor was reinforced over time. The explanation for this reinforcement is found in the existence of a circular link between productivity and popularity or attention. The increasing popularity of a given individual increases the attention that he or she receives, which in turn increases his or her productivity, and so on. The more popular the subject, the more he or she contributes, and more contributions give rise to more popularity. The mutual reinforcement between (increasing) productivity and (increasing) popularity takes the form of positive feedback.

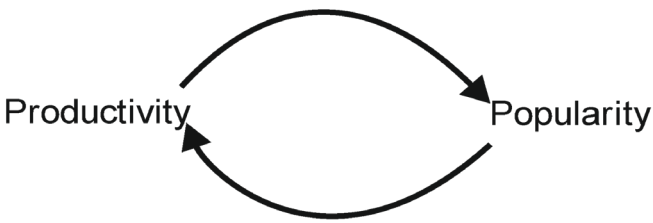

Figure 4. Positive feedback between productivity and popularity.

To explain why such feedback exists in the first place, we must also consider publicity, as measured by the number of "fans" (in Digg) or "subscribers" (Youtube). Again, there is a positive feedback loop. As the authors of the study pointed out, a considerable proportion of the attention that a contributor receives can be attributed to his or her fans. Thus, a contributor with many past contributions (high productivity) naturally has many fans (high publicity). These fans pay a lot of attention to the poster's next contribution (high popularity), which in turn incentivises the contributor to make more contributions (higher productivity), thereby closing the reinforcement loop. Based on this positive feedback mechanism, the authors were able to rigorously deduce the power law distributions which were the starting point. These power laws result from the interactions between individuals (as measured by attention). In our opinion, this is a remarkable result: the form of the media is deduced as a mathematical characterisation from a mechanism of social interaction.

Allow us to clarify. The deduction of a power law is based on the interactions between contributors and followers, which consist of attention. Attention does not exist either in the contributor or in the follower: it results from the interaction between the two poles of the relationship. By contributing as a function of the attention he or she receives, the contributor is actually copying this attention, turning into self-attention the attention that the follower directs towards the contributor. The contributor's productivity therefore aims to maintain this level of attention to himself or herself in the future, which translates to more self-attention, and this fuels the continuation of productive effort. It is a form of self-desire, a structure in which the subject's self-desire is a copy of the desire (attention) that

others direct towards the subject, and this self-desire then translates into more productivity and further increases the desire of the others. This corresponds precisely to the structure of desire identified by French author René Girard in his theory of mimetic desire, and more precisely to the type of mimetic desire he called pseudo-narcissism (Girard, 1961). Underlying the new media power law distributions is pseudo-narcissistic desire: the contributor produces because he or she aspires to the desire of others. The new networked digital media structure should therefore be characterised in terms of desire, rather than in terms of autonomous individuals.

The results presented above, and our conclusions, were obtained at a time when Facebook was not yet the largest social media network. Facebook is primarily the creation of Mark Zuckerberg, who was strongly influenced by the cyberculture ideology pervasive in Sillicon Valley, and who intended this to be the technology that would finally implement the communicative ideology proposed by Wiener five decades earlier. On many occasions, Zuckerberg has insisted that "connection" and "sharing" are entirely good things. For instance, he wrote in The Washington Post:

Six years ago, we built Facebook around a few simple ideas. People want to share and stay connected with their friends and the people around them. If we give people control over what they share, they will want to share more. If people share more, the world will become more open and connected. And a world that's more open and connected is a better world. These are still our core principles today (Zuckerberg, 2010).

Is this really the case? We repeat that, by design, a social network such Facebook facilitates the propagation of mimetic desire. This desire is mediated by "likes", "shares" and "followers". Popularity attracts more popularity, desire attracts desire, and the search for attention is unending, since each individual seeks to be a model for others based on numbers of "views", "likes" or "followers". This phenomenon has reached an extreme on networks such as Instagram, where competition for numbers of followers seems to have become almost the sole purpose of using the network.[4]

In fact, at the level of individuals, the ubiquitous "good connectivity" proposed by Zuckerberg favours the development of pathologies. As well as being fertile ground for the spread of pseudo-narcissism, digital social networks show the proliferation of what can be called pseudo-masochism. This type of desire can be thought of as the correlate of pseudo-narcissism: for each (pseudo) narcissist there is potentially a (pseudo) masochist, because the superiority and ability of former to attract the desire of others implies that someone is in the position of inferiority, trying to emulate the superior being of the person acting as a model. If there is a "followed" and an "influencer", there must be "followers" and "influenced". This relationship can generate pathologies of desire whose consequences for

4 A search of the Internet reveals hundreds of strategies that promise to win the competition for likes on Instagram. More pertinent is the testimony of several women published in *The Guardian*: 'Young women on Instagram and self-esteem: "I absolutely feel insecure"' (2015, November 4, *The Guardian*). Available at: https://www.theguardian.com/media/2015/nov/04/instagram-young-women-self-esteem-essena-oneill.

well-being and emotional balance can be particularly harmful.

This last type of behaviour is well documented by empirical studies of Facebook. Particularly relevant is the "passive following" behaviour that arises when an individual is not active (creating public profiles, publications, etc.) but is simply following a more or less inaccessible model that is the object of his or her attention. An extensive investigation in 2014 found that those who spend a great deal of time browsing and following Facebook profiles tend to feel emotionally low and depressed, and to regret the loss of time. One might expect that this would lead the individual to abandon the practice, but on the contrary, the study concluded that he or she will continue to spend time browsing the network, cherishing the dream of a sudden and magical change in luck that would lead him or her to feel better (Tandoc Jr. et al., 2015). This is the clearest manifestation of pseudo-masochistic behaviour: the subject is constantly attracted to the model, which is simultaneously an obstacle, since the supposedly superior state of being (i.e. being a model) is never achieved. Instead of abandoning this chimerical quest, the subject continues to hope that one day he or she will finally reach the fullness of being that is attributed to the desired other. In the language of psychology, the subject becomes *addicted*, that is, addicted to permanently following others, despite the discomfort involved. In other words, social comparison and envy are essential dimensions of pseudo-masochism. Envy is really the main driver of passive following behaviour, since a positive correlation can be demonstrated between passive following and envy on Facebook (Krasnova et al., 2013), and it has been observed that individuals who frequently use Facebook have higher levels of envy than occasional users (Tandoc Jr. et al., 2015). Envy is the desire to possess the qualities or goods that are considered inseparable from another individual, and on Facebook, the intensity of social comparison based on envy occurs on a scale without precedent in the real world (ibid.). In fact, a positive correlation was also found between the time spent on Facebook and social comparison. The negative consequences in terms of mental health were also investigated, as social comparison was found to mediate the existence of a positive correlation between the use of Facebook and depressive mental states. In short, it can be concluded that the use of Facebook leads to unfavourable social comparisons and the proliferation of envy, which in turn leads to depression (on these points, cf. Appel et al., 2016). We are very far from a "more connected and better world".

2. Sentiment analysis and negative emotions

The previous results dealt with individual behaviours; we must now analyse studies that emphasise the social dimension of these behaviours. Recently, techniques have been developed that allow for research on the presence and diffusion of emotions in social media. This is an area of investigation called sentiment analysis, in which it is possible to ascertain the emotional attitudes expressed in the comments of users of social networks through algorithms based on artificial neural networks (cf. Liu, 2015, for an overview). These comments are associated by the computational model with a certain emotional value, which may be negative, neutral or positive. This line of research was further developed in

2014, when a group of researchers working for Facebook Inc. demonstrated empirically that emotions can spread through imitative contagion on networks, namely on Facebook, on which the study was based (Kramer et al., 2014).

Sentiment analysis studies show that, in general, the "negative" tends to prevail and spread more quickly than the "positive" or the "neutral". For example, it has been shown that, on Twitter, negative emotional tweets have more retweets and spread more quickly than positive ones (Stieglitz and Dang-Xuan 2013). Negative emotions include "anger", "anxiety", "fear", and "disgust", while "joy" is considered to be a positive emotion. In addition to being classified according to "negative" or "positive" valence, emotions can also be classified according to the arousal they induce. The general conclusion that can be drawn from sentiment analysis is that negative emotions have a greater impact than positive ones; that is, they spread more quickly and infect a greater number of individuals than positive emotions. The same is true of emotions expressing greater arousal, a dimension in which, for example, anger or fear spreads more quickly than sadness or joy. Negative emotions produce more engagement with the network, as measured by the number of "comments", "shares", etc.

A particularly significant study focused on Weibo, a large Chinese social network (Fan et al., 2014). The authors investigated the spread of "anger", "disgust", "sadness" and "joy", and contrary to expectations, found that anger had a much greater correlation between users than joy, and that the correlation for sadness was trivial. This means that anger spreads quickly by contagion on the network, while joy and sadness barely affect individuals who are connected to other individuals who express these emotions in their comments (cf. the explicit calculations in pp. 6-8 of Fan et al., 2014).The negative emotions are much more likely to propagate by imitation than positive ones, and in the discussion below, we will begin to understand why. Figure 5 shows the results obtained from Weibo, where the clear dominance of anger can be seen.

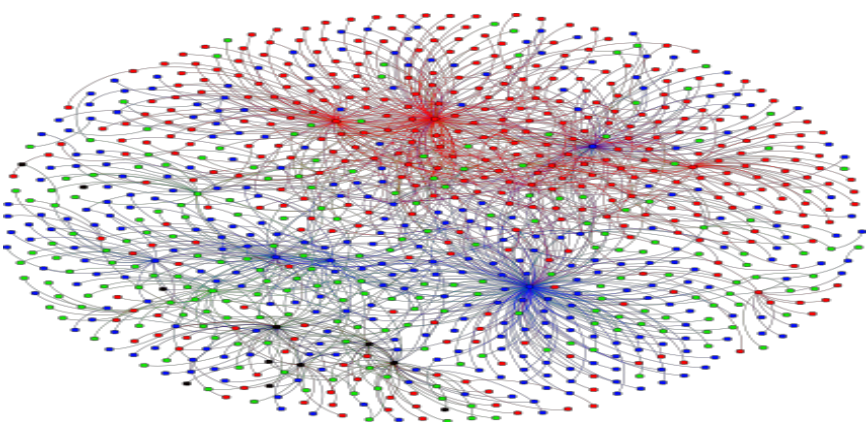

Figure 5. The spread of emotions on the Chinese social network Weibo. The red nodes express "anger", the green "joy", the blue "sadness" and the black "disgust". Source: Fan et

al. (2014).

It is important to stress that in sentiment analysis, we are considering the *content* of publications. This is a step forward in relation to the previous analysis of the reasons that lead individuals to publish (in YouTube and Digg, cf. above). In the latter case, only the number of publications (nodes) and the amount of attention received (measured by links) by the nodes were in question. But is it not also possible to draw a relationship between negative emotions, content, the number of publications, and even the existence of power law distributions? One empirical study on a digital public forum of discussion found results that, in our opinion, are important and enlightening (Chamiel et al., 2011). The authors started by noting that negative emotions increase the number of publications; that is, participants with more negative emotions write more. There is a correlation between activity and negativity. The level of activity (in terms of publications) does not necessarily influence emotions, meaning that an individual can publish a great deal without expressing certain emotions (namely negative ones), but there is a correlation between emotions and activity, that is, if negative emotions are expressed, then there is a lot of activity. Furthermore, the study shows that there is a power law distribution for publications by participants. The individuals who act as central nodes (hubs) have a large number of publications expressing negative emotions, and these individuals disseminate negativity in all discussion forums. We stress that if there is a correlation between negativity and publications, then as a consequence, the longer the discussion of a certain topic, the greater the emotionally negative content. This is one core conclusion: *the more we communicate, the more communication degenerates into negativity*. So, by an exact empirical analysis of digital social media, we reach a conclusion opposite to the communicative ideology expressed by Wiener and Zuckerberger, in which "connection" and "communication" are a good thing.

This tendency towards negativity has also been found in more recent studies of Facebook. As is now widely known, these studies show the existence of "echo chambers" in social networks, which are accompanied by a growing polarisation, that is, a tendency for groups to oppose each other (del Vicarioet al., 2016). Again, the longer the discussion, the greater the negativity towards others. Communication is an *act of reciprocity*, but contrary to the view that has often been defended, and in particular by cyberculture, reciprocity can be bad reciprocity, in which each individual tends to *imitate* the negativity of the other. As the studies referred to above indicate, and our following analysis will show, it is far easier to imitate negativity than it is to imitate, and sustain, good and positive reciprocal communication.

What is the root of the engagement, dominance and spread of negative emotions and communicative polarisation? The participatory engagement of emotions results from the fact that they are direct interactions between individuals. Emotions are intersubjective ties that are not based on a common reality, exterior to and independent of the relationships between individuals. They express indignation, anger and hate, and refer to another individual or group of individuals who are their objects. Due to imitative contagion in a

network, individuals start to conform to each other and perceive themselves as identical, as a group united by the emotion that is common to all of them; that is, they perceive themselves as identical in terms of their anger, which is directed at an individual or group that is different. This individual or group is blamed for any malaise, disorder or social crisis, and is held responsible for intentionally (and often using hidden methods) causing this disorder. He, she or they may also be held responsible for morally highly reprehensible criminal acts. The group against which an emotional polarisation is directed may also be a different group in the sense that it has bodies, behaviours, rules or systems of ideas that threaten the stability of the bodies, behaviours, rules or systems of ideas of the persecuting group; that is, the identities of those in the group tend to be dissolved in the presence of what is different (cf. Girard, 1982: 32-35). The consequence is that the group polarises itself against a different and ostracised group or individual, to which the anger of each member of the persecuting group is transferred.

3. Emotions, Imitation and algorithms

What are the aspects of the new social networks that favour the ancestral tendency to blame, persecute and ostracise other individuals? Firstly, these new networks are really non-institutionalised media. They represent the end of communication as an institution, as typified by traditional mass media. (cf. Machuco Rosa, 2016). As we have seen, the absence of regulation was a positive development for proponents of cyberculture, an opinion that is also shared by the creators of social networks, for whom this type of ideology is particularly useful. The Electronic Frontier proposed in the nineties that online communities should set their own standards, without external regulation. However, following the facts that have arisen in recent years, the need to regulate this new form of media has become clear. The new "participatory media", enthusiastically celebrated over the past decade (for example, Time magazine elected "You", i.e. participatory individuals, as "person of the year" in 2006), have come to be seen as a threat, precisely because the implications of the "participation" of a gigantic number of undifferentiated and anonymous individuals have become clear.

Secondly, contrary to Rheingold's beliefs, the absence of physical interaction in communication does not contribute to good communicative reciprocity. On the contrary, disembodied communication and anonymity eliminate the behavioural constraints that exist in physical communication. Without these constraints, communication can quickly degenerate into negativity, with each participant feeling that he or she can freely respond to the other. Verbal violence can spread quickly, and that is precisely what has been observed in the spread of negative emotions. The diffusion of emotions can also be associated with the high temporal frequency of publications, comments, replies, with each individual imitating the other's bad communicative reciprocity at faster and faster rates.

Thirdly, we stress again that the new digital media are networks in the precise sense of this expression. Besides the presence of distributions in the form of a power law, this implies that they are global networks with the existence of a giant component (i.e., a

path starting at a given individual can reach any other individual - see the image of the Weibo network in Figure 5 as an example), which guarantees the wide dissemination of information. It can even be demonstrated that there are critical points from which information spreads via imitative contagion to "infect" all of the nodes in the network.[5] Although there are many links and connections, giving rise to a lot of "communication", this is far from being necessarily positive (remember again the Weibo network and how anger spreads). In addition, the speed of diffusion of information is favoured by the fact that these networks are "small worlds". This means that the average distance (measured by the number of intermediate nodes that must be passed in the route from one node to any other node) between the nodes of a network is small. This is generally presented as a positive aspect—we are "increasingly interconnected"—as when researchers from Facebook Inc. found experimentally that, in 2016, the average distance between any two "friends" in the network was 3.5.[6] However, we have seen here that that negative emotions spread more easily. Small-world networks facilitate the propagation of information, when the aim should be to block this propagation.

There is a final crucial factor that not only facilitates but amplifies the spread of negative emotions across networks. This is the systematic use of *ranking algorithms*. These could also be called popularity sorting algorithms or, perhaps even better, imitation amplifiers. Most social networks use this type of algorithm, which were introduced when Google Inc. defined PageRank as the algorithm on which its search engine was based (cf. Brin and Page, 1998). Ranking algorithms are essential in order to automatically generate lists of recommendations, as is the case with Amazon and the algorithm that YouTube uses to recommend videos.[7] Here, we mainly analyse the algorithm used by Facebook, which determines the order in which content appears in the "news feed" of each user. It should be noted that this represents a profound change from the way news is broadcast and received in traditional media: the relevance of news is now classified by an algorithm, and has nothing to do with the intrinsic quality of a news item. We will now see that this relevance is simply the consequence of imitation and the user´s engagement with a certain source.

The Facebook algorithm is constantly being updated, and is a proprietary algorithm about which only the Silicon Valley based corporation knows the details. However, we know the rudiments of its content.[8] Around 2016, the central core of the algorithm obeyed the following equation:

News feed visibility = C * P * T * A

where **C** designates the interest or engagement, as measured by "likes", "comments", etc., of the user in the publications of a news source (any type of content with a certain origin);

5 For an overview of the mathematical properties of networks, see for instance Dorogovtsev and Mendes, 2003.

6 Cf. the publication available at: https://research.fb.com/blog/2016/02/three-and-a-half-degrees-of-separation/.

7 On the effects caused by the YouTube algorithm, see the report in *The Guardian* entitled 'Fiction is outperforming reality: how YouTube's algorithm distorts truth' (2018, February 4, *The Guardian*). Available at: https://www.theguardian.com/technology/2018/feb/02/how-youtubes-algorithm-distorts-truth.

8 A detailed description is available at: https://techcrunch.com/2016/09/06/ultimate-guide-to-the-news-feed/. Here we follow the analysis by Sumpter, 2018.

P designates the interest that other users who are friends of the first user have in the same source of news; **T** designates the publication format (status, link, photo, video, etc.); and **A** classifies publications according to their date. The algorithm has become increasingly complex, and is able to process thousands of parameters (for example, in T), and as mentioned above, its details are known. For our purposes, however, it is sufficient to apply its basic structure. We can simplify the algorithm as follows:

Visibility = interest of user in a source of news × closeness to a friend sharing the same source

In other words, if we define the *engagement*, E, as the interest of the user in the source and also relate this to the closeness of the friend, with closeness defined as sharing the same source, we have

Visibility = Engagement squared (E^2)

Visibility is proportional to the interest in the source multiplied by the closeness of the friend. It is essential to note the presence of the nonlinear term E^2, since this defines Facebook as an *interactive network*. The algorithm does not simply display news in the user's feed from a source with which that user has engaged in the past; it also multiplies the engagement of the user by the engagement of a friend with the same source. The presence of the third party is crucial, and it is this triadic structure that, in our opinion, defines Facebook as an *interactive* network (see Figure 6). The triad is the basis of interactive complexity. It should be noted that in its actual operation, the algorithm obviously does not only calculate the engagement of one friend, but also calculates the interactions of all friends (in the limit, all users of the network) with a certain source, and then for all sources (who are also users) and all users (who are also sources). We have a global synergetic network in which any node may potentially influence any other.

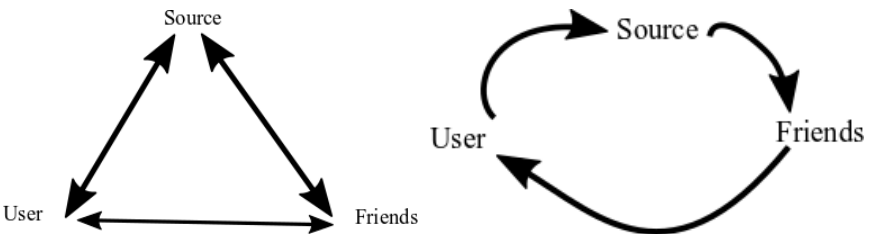

Figure 6. The triadic structure of the algorithm used by Facebook's news feed.

Although this point cannot be demonstrated, since the details of the algorithm are not fully known, it is relatively intuitive to infer that the algorithm converges to a *fixed point* of the contents with which a user interacts. That is, depending on both past user engagement and

the engagement of friends with whom the user interacts, an individual will tend to interact with the same type of content. Past interactions with a certain content that others have also interacted with tend to be amplified nonlinearly by the algorithm: the likelihood of interacting with the same type of content is always growing. If I, as a friend of mine, and for whatever reason, initially choose a source A instead of B, then I will increasingly be oriented towards A, which becomes a fixed point in my order of preferences.

The algorithm is a positive feedback mechanism: it takes my and my friends' actions as input, and provides an output that again forms the input for my subsequent actions. The algorithm amplifies our tendencies, generating more and more imitation, and thus individuals are reduced to uniformity and identity. The algorithm is a mediator that eliminates diversity and always provides more of the same; it is a process that automatically generates *imitation and identity*. It favours the formation of identity groups, echo chambers and polarisation (cf. del Vicario et al., 2016). Based on this, there seems to one inevitable conclusion, since we know what generates more engagement; as we pointed out above, it is negative emotions such as anger that generate polarisation, tribalisation and ostracisation. Hence, it is precisely these emotions that the algorithm will rank at the top of its viewing lists and recommendations, and since they are more numerous and more visible, they become a fixed point of the opinions expressed. Cyberspace, initially seen as a space for rational communication between free and autonomous individuals, has through the mediation of algorithms become a space for the propagation of imitation and emotions.

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