The Bridges and Brokers of Global Campaigns
in the context of Social Media

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Abstract

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Keywords: contentious politics; digital protests; online social networks; structural constraint; modularity structure; network robustness.

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1. Introduction

Digital technologies are transforming the way in which protests are organised. Online networks blur the boundaries between private and public activities and create more efficient channels for recruitment and mobilisation. News about protests and political campaigns can now travel faster because the channels for diffusion are laid down and ready to be activated: social networking sites (SNSs) and mobile technologies allow people to be constantly exposed to the activities of their group of reference, becoming recipients of information even if they are not actively searching for it; as a consequence, political communication flows through networks that are not necessarily political in nature, which reduces the costs of logistics and expands reach beyond traditional publics. Technologies that conflate private and public interactions mark a turning point in the evolution of political protests: mobile applications are more successful at merging those two spheres than web sites and platforms. The first generation of digital tools required users to search information and enter specific protest circuits (i.e. alternative media platforms like Indymedia) to obtain news about mobilisations. Dissemination could be fast then as well (Earl & Kimport, 2011), but it was hampered by the fault lines separating public activities from private interactions.

Amongst the second generation of online technologies, SNSs and their mobile applications have been particularly efficient at extending the exposure to information
received from personal contacts (Rainie & Wellman, 2012). An increased exposure to information means that reaction times to news and events are reduced, which on the aggregate accelerates the emergence of group dynamics and spikes of activity – dynamics that underlie swarm activism (Rheingold, 2002) and the virality of content (Berger, 2013). These network effects, which rely on the structures of interaction that people build with their contacts online, are reinforced by the personalised way in which information disseminates: news and calls for action come now from recognisable individuals that people choose to include in their group of reference; because they are personal, these interactions make people pay more attention to the information exchanged and also more likely to react to it (Bakshy, Rosenn, Marlow, & Adamic, 2012; Bond et al., 2012). A combination of these factors allows online networks to be, in principle, more efficient and effective mobilising structures.

The wave of protests that started in 2011 in the Middle East and North Africa region – to soon resonate in many other countries around the world – suggests that digital technologies can certainly materialise their potential and mediate in crucial ways contentious politics. However, empirical studies analysing the actual mechanisms through which this mediation takes place are scarce, which casts shadows on many theoretical claims about the role that digital media plays in the organisation of political mobilisations. In particular, in the field of communication the language of networks is often used to refer to the ways in which digital technologies reconfigure collective action and protest: scholars talk about “networked social movements” (Castells, 2012) and the logic of “connective action” (Bennett & Segerberg, 2012) to highlight the impact that personalised communication have on organisational structures, now more fluid and horizontal. Yet this network language is rarely ever put to an empirical test, which prevents the theoretical discussion from entering a more nuanced assessment of how networks actually emerge online and facilitate (or hinder) protest communication.

This paper takes the theoretical discussion on contentious politics and digital media to that level of analysis. It focuses on the dynamics of online communication around the protests that took place in May 2012 to celebrate the first anniversary of the ‘indignados’ movement. This call for action originated in Spain but it was launched as a global campaign with explicit linkages to the Occupy movement, which emerged in the U.S. in September of 2011 inspired, in part, by the ‘indignados’ themselves. This study is a follow-up to previous work analysing data from 2011 that tracked the emergence and growth of the ‘indignados’ through the recruitment channels of an online network (González-Bailón, Borge-Holthoefer, & Moreno, 2013; González-Bailón, Borge-Holthoefer, Rivero, & Moreno, 2011). This follow-up provides data with which to assess how much the movement changed during its year of existence, and in particular, how integrated it became with Occupy protesters.

Previous work considering transnational activism assumes that online networks facilitate global connectivity, encouraging communication across borders by means of decentralised information structures; it also assumes that these networks are very robust because they are fluid, adaptable, and less vulnerable to manipulation or repression due the lack of an identifiable centre (Bennett, 2003; Castells, 2004, 2009; Juris, 2008). This view has been reinforced by media and journalistic accounts of the recent wave of protests around the world (Andersen, 2011; Mason, 2012),
which place online networks at the core of the seemingly contagious effects of protest activity. The analyses that follow aim to shed light on those assumptions by looking at the actual communication taking place during the course of political mobilisations. In particular, we pay special attention to the ability of online communication to bridge local movements into a single connected network of information exchange – a precondition if global diffusion is to take place.

The analyses rely on data collected from Twitter, and focus on three aspects of the network of communication that protesters built on this platform: the structure of the network, the properties of which shape information flows; the position of users that acted as information brokers, linking the two movements with messages intended for both audiences; and the robustness of the network, that is, how resilient its global connectivity is to node removal. The findings suggest that the global connectivity of the network relies on a small percentage of actors, and that these actors tend to be the brokers, themselves a small minority in the large collective of people involved in protest communication. The data draws a picture where the two movements are mostly concerned with their own local struggles: the bridges that connect them channel just a small percentage of all information exchanged. In brief, this picture reveals that online protest networks are not as global, fluid or robust as has been claimed.

This work points to possible improvements in the communication strategy followed by protesters: the network would certainly benefit from more bridges and more redundancy in the exchange of information, which would strengthen alliances and create alternative ways for information diffusion instead of making the network rely on a small number of users for brokerage. But most importantly, it suggests that the theories that have been proposed to understand new forms of collective action are out of sync with how protest communication actually operates. The following section explores in more detail these theories, and it distils the assumptions that will be tested in the empirical analyses. The protest activity analysed is contextualised in section 3, and the data and methods employed are presented and discussed in section 4. A discussion of the findings follows, before the paper concludes with an outline of future lines of work, including the need for a more careful exploration of the network mechanisms that underlie digital protests.

2. Protest Mobilisation in the Digital Era

The study of contentious politics in the last two decades has versed much attention to the role that digital networks play as organisational structures. Since the global justice movement erupted in the nineties – with visible examples including the Zapatistas indigenous struggle and the Seattle protests against world trade negotiations (Bob, 2005; Castells, 2004; Cleaver, 1998; Shepard & Hayduk, 2002) –, researchers have tried to dissect the transformational effect that the Internet has on political mobilisation. The discussion has focused on two levels: the impact of online networks on the power structure, which relies on communication and the ability to frame events and narrate reality (Castells, 2009); and their impact on the costs of collective action, especially by lowering entry-barriers and making co-presence in time and place less necessary (Bimber, Flanagan, & Sthol, 2005; Earl & Kimport,
2011; Lupia & Sin, 2003). Taken together, these two approaches assess the symbolic and instrumental role of online networks when facilitating social interactions.

On the first level, the main argument is that with the arrival of the Internet, people could start bypassing mainstream media and the communication channels created by the establishment to perpetuate its dominance. Digital technologies give people the chance to self-communicate massively, and write their own interpretation of events, which re-wires not only communication networks (and the power embedded in them), but also mindsets, beliefs and, ultimately, actions. Indymedia, an independent media centre closely linked to the organisation and coverage of global justice protests (Klotz, 2004; Shepard & Hayduk, 2002), stands as an iconic example of the kind of empowerment brought about by online networks. Protesters had their own means to report events as they happened and recount them later in their own terms: ‘anti-globalisation’, for instance, was the label most often used by mainstream media to refer to protesters against world trade negotiations, but protesters themselves preferred the names ‘global justice’, ‘anti-capitalist’ or ‘fair trade’ (Garrett, 2006). Each of these appellatives has different connotations and implications for how audiences react; online communication helped steal from mainstream media the power that words have to define reality.

On the second, more mundane level, online networks helped cheapen the costs of mobilisation, and lowered the entry barriers for groups and causes that would not have been able to spread their message otherwise. This impact is instrumental rather than symbolic (Diani, 2000), but facilitated the emergence of transnational networks and the coordination of local struggles under the umbrella of global alliances (Bennett, 2003). The Zapatista uprising is again an example of how online networks helped build alliances and market the principles of their rebellion to a global audience (Bob, 2005); but other examples are more institutional: the International Campaign to Ban Landmines, for instance, which was awarded the Nobel Peace Prize in 1997, epitomises how online networks can be used to increase the speed and efficiency of transnational mobilisation (Hajnal, 2002: chapter 5; Klotz, 2004: 86-7). These networks were mostly based on hyperlinked web resources, and protest repertoires included email distribution lists, online petitions, and denial of service attacks (Van Laer & Van Aelst, 2010). They created epistemic communities that anybody with an Internet connection could access through one of its many entry points; but the main nodes in these networks were still organisations with traditional formal structures trying to improve their public relations and outreach activities.

Digital technologies evolved, and with them, online networks. The launch of SNSs brought the ability to connect to individuals to an extent that neither websites nor blogs or other online technologies had managed to do before – partly because they were launched when more people were online, partly because these services capitalised on existing personal networks. This shift accelerated the transition, already in motion, towards ‘networked individualism’ (Rainie & Wellman, 2012), that is, a social arrangement in which identities are not shaped within the confines of groups with clear collective boundaries, but arise instead from interactions in complex networks where social circles overlap, and are sometimes mutually exclusive. Political interest rises and falls in these networks like a tide with irregular cycles and
heights; but the networks remain, providing the basic infrastructure for everything that is social, including mass mobilisations.

Scholars of social movements have long considered how interpersonal networks can operate as informal organisational structures, creating one of the most important channels for protest recruitment and mobilisation (Diani & McAdam, 2003; McAdam, Tarrow, & Tilly, 2001). What makes theoretical accounts of digital protests depart from this tradition is the suggestion that online networks “transcend time and space” (Castells, 2012: 218-237) as well as “the elemental units of organizations and individuals” (Bennett & Segerberg, 2012: 753). This, the argument goes, is what grants online networks greater fluidity and the ability to react and adjust rapidly to shifting targets, crossing geographic and temporal boundaries as needed; and it is for this reason that the logic of collective action in the digital era “invites analytical attention to the network as an organizational structure in itself” (Ibid.). The problem is that when that attention is paid, these theoretical claims are difficult to reconcile with the empirical evidence.

For instance, findings suggest that geographic factors still constraint the emergence of digital networks (Allamanis, Scellato, & Mascolo, 2012) and the way in which protest information flows, which is also highly time-dependent (Borge-Holthoefer et al., 2011; Conover et al., 2013); in other words, rather than transcend time and space, communication through online networks responds very strongly to those constraints. The analysis of how information flows in online networks also contradicts claims such that “movements are viral, following the logic of the Internet networks” (Castells, 2012: 224). Online networks can channel the diffusion of protest activity as offline social networks did before the Internet could mediate the process (Hedström, 1994); but the reality is that they fail to diffuse information more often than not (Goel, Watts, & Goldstein, 2012), so there is nothing intrinsic to Internet networks that promotes virality. These inconsistencies highlight even more the need to pay “analytical attention to the network as an organisational structure”, especially if we are to improve our theoretical understanding of how political communication unfolds online.

Previous work on digitally-enabled protests has contributed greatly to our theories of contentious politics by underlining how communication networks help articulate those movements. But if the theoretical discussion is to advance to new levels, the language of networks needs to be taken literally, not metaphorically: it does not help to say that online networks are horizontal and prone to contagion and virality when in fact communication in those networks is very centralised and the global spread of information highly unlikely. The mechanisms by which online networks mediate political protests are complex, and need thorough empirical assessment. On an abstract level, it might be useful to employ network talk as shorthand for the informal structures and self-organisation that characterise digital movements; but to analyse how these networks work in the actual process of organising protests, the language of networks has to be used analytically – that is, in the less ambiguous language of graph theory and network science. If the metaphors do not stand empirical scrutiny, they cease being useful: they just limit our understanding of how online communication networks boost or knock contentious
action. This paper runs one such empirical test using the interactions across the ‘indignados’ and Occupy movements as a case study.

3. The ‘Indignados’ and Occupy

The protest movement that was to become the ‘indignados’ brewed up online in the early months of 2011, in the heated atmosphere created by the financial crisis. The movement rose as a response to the politics of austerity imposed by the Spanish government, and it was fuelled by the uprisings in the Middle East and, in particular Egypt, which became a source of inspiration for many protesters (Andersen, 2011). There were, however, many local precedents and campaigns that also gave muscle to the movement. These included ‘nolesvotes’ (don’t vote for them), which had risen a few months before to protest against restrictions to internet freedom, launching an online campaign to punish the political parties that had approved a law aimed to curtail file-sharing (the Ley Sinde); Juventud sin Futuro (Youth without Future), which had long been using social media to mobilise students and young people to protest against unemployment and the lack of professional opportunities; Estado del Malestar (Badfare State), a group of activists campaigning against cuts in public services; and the Plataforma de Afectados por la Hipoteca (Platform for Mortgage Victims), which was founded two years before to protest against evictions and defend the right to housing (Castells, 2012: chapter 5; Gerbaudo, 2012: chapter 3). When the group Democracia Real Ya (Real Democracy Now) launched their campaign against austerity and corruption in the early months of 2011, many of these other groups joined the online discussions, and contributed to the growth of the movement.

Democracia Real Ya (DRY) emerged as a network of blogs and online platforms that gravitated around a discussion group in Facebook. The platform and their manifesto (opened with the lines “We are normal people. We are like you”) gained a lot of attention through networks like Facebook and Twitter, which played a significant role in attracting interest and promoting conversations among protesters, journalists, and sympathisers. A demonstration day was planned for May 15, a week prior to regional and municipal elections. This call was supported online by thousands of individual users and by hundreds of civil society organisations and, on the demonstration day, it received offline support by hundreds of thousands of protesters who turned up in the streets of many cities around the country. All these people had learned about the call through online networks: mainstream media had blocked the coverage of the demonstrations in spite of being invited to a press conference and having been informed that the demonstrations would take place (Castells, 2012: 116-120). The analysis of communication activity before the demonstration day suggests that online networks were indeed instrumental for recruitment and information spreading (González-Bailón et al., 2011), before the media were even formally informed of their planning.

After the demonstrations on May 15 some protesters decided to camp in public squares until the date for municipal elections, which were to take place throughout the country on May 22. During that week the visibility of the movement in mainstream media grew exponentially, and so did online activity around it (Borge-Holthoefer et al., 2011; Vanilla-Rodirguez et al., 2012). With the formation of camps,
a lot of the communication started to take place in the physical space of squares, where assemblies and public deliberations were organised on a daily basis, and the symbolic framing of the movement underwent constant discussion and redefinition. Online networks, however, were still buzzing, reflecting some of the changes in the framing of the protests (González-Bailón et al., 2013). Election Day arrived, and after that, the movement started to wind down. The camps were dismantled, and online networks entered a dormant phase – groups of people still organised locally, in the associational spaces of neighbourhoods and societies, but they lost their unity and ability to mobilise massively.

These protests left behind a trail that was to lead to the emergence of the Occupy movement. When the Canadian activist magazine Adbusters launched a call in July of 2011 to occupy Wall Street, the idea was to exploit the tactics introduced by the Egyptian uprising and the Spanish ‘indignados’, to encourage “a fusion of Tahrir with the acampadas of Spain” (Adbusters, 2011). The call established September 17 as the date for action, and during the intervening months, online networks were targeted with messages (and #OccupyWallStreet hashtags) and symbolic imagery, including the famous picture of the ballerina posing on the back of the Charging Bull in the financial district of Manhattan.

The beginnings of the Occupy movement are different from the ‘indignados’ because it was originally orchestrated by established (albeit alternative) news media (Gerbaudo, 2012: chapter 4). Only when organisers on the ground got involved, which included groups from the anarchist scene of New York but also other grassroots and community-based organizations (Castells, 2012: 161), did the movement start to consolidate and grow. Other online groups, like the hacktivist Anonymous, helped spread the message through online networks, and the Spanish ‘indignados’ themselves contributed to the spread of the Occupy call as early as July. The process of making the movement take off, however, took longer than in the Spanish case – although it ended up resonating more widely around the world.

The estimated number of people gathering in Manhattan on September 17 ranges from 1,000 to 5,000 – which fell far from the original target of mobilising 20,000 people. The movement spread to other cities in the U.S. only after some violent police reactions and the massive arrests that followed the Brooklyn Bridge march on October 1. The dynamics of that spatial diffusion reveal high levels of locality in the patterns of communication and a very unequal distribution in the allocation of attention, with a small number of locations (New York, California, and Washington D.C.) absorbing most of it (Conover et al., 2013). After these events, the movement became a global phenomenon, with the slogan “we are the 99%” taking root in the imagination of the public. Again, Facebook and Twitter were essential tools for communication and mobilisation – to the point that some protesters felt uneasy for depending so much on proprietary tools, in conflict with the openness of the movement (Ibid: 175). One of the first explicit connections linking the Occupy and the ‘indignados’ protests came with the international call for action planned for October 15 under the slogan “United for Global Change”. Mobilisations were organised in more than 900 cities in 85 different countries around the world (Ibid: 269). Many of these protests resulted in new camps.
Since then, and with the camp sites ultimately dismantled, the movements have been dormant and not very visible offline. They have still been active in online networks, although with lower frequency of communication. The noise started to build up again as the date of the first anniversary of the ‘indignados’ approached, and a new international call for action was planned for May 12, 2012, again under the slogan “United for Global Change”. This is the protest we track here. We pay special attention to the interactions between the ‘indignados’ and the Occupy protesters, as they communicated online. We want to test two things with this data: first, whether the network is as globally connected as the slogan suggests; and second, if the number of connections bridging the two movements gives the network enough structural resilience to maintain that connectivity.

4. Data and Methods

We collected data during the period 30 April to 30 May using the Twitter search API, querying for messages that contained the top 5 hashtags related to the ‘indignados’ movement, identified in previous work (Borge-Holthoefer et al., 2011), and variations of the word ‘occupy*’. A total of 606,625 messages were collected. Because hashtags are often co-used, these messages contained many other hashtags we did not search for (close to 30 thousand). A list of the top 100 hashtags in terms of frequency of use can be found in the Appendix. Using these hashtags as a proxy to content, we classified messages as being related to the ‘indignados’ or to the Occupy campaigns. Many of them, however, contained hashtags relevant for the two movements, creating bridges across the two streams of information. The analyses that follow focus on these bridges and, in particular, on the users that created them – we call these users information brokers because they mediated information exchange across the two protest communities.

Every message in our sample is linked to a unique user ID, which we used to snowball the following/follower structure. The one-step snowball crawl returned a network of more than 38 million users; of these, we only retained users that had sent at least one protest message during the period we observe, as well as their connections to other users that were also involved in this communication. In addition, we parsed the messages to identify re-tweets (RTs) and mentions (@), which allowed us to reconstruct direct interactions and explicit channels of protest information flow. These three networks, which are nested layers of the same underlying communication structure, are summarised in Table 1.
### Table 1. Descriptive Statistics for Communication Networks

<table>
<thead>
<tr>
<th></th>
<th>following/follower</th>
<th>RTs</th>
<th>@mentions</th>
</tr>
</thead>
<tbody>
<tr>
<td>$N$ (number of vertices)</td>
<td>125,219</td>
<td>85,307</td>
<td>60,485</td>
</tr>
<tr>
<td>$E$ (number of directed edges)</td>
<td>8,510,654</td>
<td>178,781</td>
<td>132,431</td>
</tr>
<tr>
<td>&lt;$d$&gt; (mean degree)</td>
<td>136</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>max($k_{in}$) (maximum indegree)</td>
<td>27,518</td>
<td>3,930</td>
<td>1,475</td>
</tr>
<tr>
<td>max($k_{out}$) (maximum outdegree)</td>
<td>9,047</td>
<td>912</td>
<td>600</td>
</tr>
<tr>
<td>$q$ (reciprocity)</td>
<td>0.489</td>
<td>0.026</td>
<td>0.055</td>
</tr>
<tr>
<td>$C$ (mean transitivity or clustering)</td>
<td>-0.139</td>
<td>-0.065</td>
<td>-0.073</td>
</tr>
<tr>
<td>$r$ (degree correlation coefficient)</td>
<td>0.27</td>
<td>0.12</td>
<td>0.38</td>
</tr>
<tr>
<td># components</td>
<td>41</td>
<td>3,485</td>
<td>3,574</td>
</tr>
<tr>
<td>$N$ giant component</td>
<td>125,135</td>
<td>76,538</td>
<td>51,505</td>
</tr>
<tr>
<td>$N$ 2\text{nd} largest component</td>
<td>4</td>
<td>53</td>
<td>76</td>
</tr>
</tbody>
</table>

The network statistics in Table 1 reveal that, as is usual in most online networks, centrality is very unevenly distributed: a minority of users concentrate most of the connections, and again a minority attract and send most of the messages (the maximum values compared to mean degree is indicative of the underlying long tailed distribution). The networks, however, are highly connected, with most users being part a single giant component.

For each user in these networks, we have the number of messages they sent, and a count of how many of these were intended for the Occupy audience (i.e. used variations of the Occupy* hashtag), and how many were intended for the ‘indignados’ (i.e. used hashtags related to the Spanish protests). We used this count to classify users in one of the two protest groups. Because the observation window we analyse includes the demonstrations to celebrate the first anniversary of the ‘indignados’, there is more activity on this side of the network and as a consequence more users are classified in this group ($N=74,007$); the rest are classified as Occupy members ($N=51,212$). About 6.45% of all users ($N=8,082$) posted at least one message relevant for the two movements by using hashtags associated to the Occupy and ‘indignados’ protests jointly. These users are the information brokers that bring the two movements together in the same stream of information; most of them (68%, or $N=5,499$) are classified as ‘indignados’ but there are also brokers amongst the Occupy users. In other words, brokerage efforts were attempted from both sides of the network.

These users differ widely on their centrality and visibility in the stream of protest-related information. Figure 1 illustrates this variance. It compares the distribution of brokers and non-brokers along two axes: the horizontal axis measures centrality in the network by tracking the ratio of followers a user has over the number of other users they follow; the vertical axis tracks user visibility in the flow of communication measured as the number of times they are mentioned over the number of times they mention other users (including mentions that are part of RTs). This distribution allows identifying four types of users, labelled in previous work as influentials (upper left corner), hidden influentials (upper right corner), broadcasters (lower left corner), and common users (lower right corner, González-Bailón et al.,
2013). The aim of this classification is to distinguish users who have large audiences in the Twitter network but might not be salient in the stream of protest-related information (like broadcasters), from users who have small or average networks, but are very visible in the exchange of protest messages, like hidden influential.

As with the data collected around the 2011 protests (Ibid.), most users fall at the intersection of dashed lines, which means that they are average both in terms of network centrality and visibility. The scatterplot also suggests that most information is channelled towards a minority of celebrities (influentials) and popular users (hidden influential), which contradicts theoretical claims about the horizontal nature of online networks: they are instead rather hierarchical structures from the point of view of how communication flows (and who gets most of the attention).

Figure 1. Centrality of Users in the Protest Communication Network

Figure 1 adds an additional dimension compared to the analysis of the 2011 data: in 2012 there is a new type of users, those who bridge information across the ‘indignados’ and the then inexistent Occupy movement. As mentioned above, we call these users brokers. Figure 1 suggests that the brokers in the network are more evenly spread, spanning the four categories of users and being represented amongst celebrities and broadcasters as well as common users. This means that information brokers cannot be characterised merely by the size of their networks, or by the amount of protest messages they send or receive. Their role in the network of communication is nonetheless crucial because without them, and the bridges they create, the possibility of information diffusion and contagion (at least in this particular network) wouldn’t exist.

To further characterise the position of these brokers, we focus on two properties of the network: structural holes and the existence of communities. We analyse the first using the measure of structural constraint developed in the field of organisational sociology (Burt, 1992: chapter 2; Burt, 2004: p. 362, n.6). Structural holes identify parts of a network were connections are low or missing, and constraint
helps identify the nodes that are in a position to span those holes. It is a measure of local density and redundancy in connections. In the context of Twitter, it is higher if a user has less, or mutually connected contacts (so connections in their personal networks are redundant), and lower if a user is connected to other users that are not following each other (which means that he has the possibility to span structural holes). The mathematical expression of the constraint of a user’s $i$ personal network with $q$ contacts is defined as:

$$C_i = \sum_j \left( p_{ij} + \sum_q p_{iq}p_{qj} \right)^2, q \neq i,j$$

(eq. 1)

Scores are then multiplied by 100 and, for the robustness tests, transformed to a logarithmic scale. The logic behind this metric is that lower constraint means an actor has higher brokerage opportunities, which brings competitive advantage: actors can decide whether to pass the information or not, and use this position to their benefit. This metric has been employed and validated in the context of complex organisations (Burt, 1992, 2005) but it has also been used to analyse interactions in online networks (Aral & Van Alstyne, 2011; Burt, 2012). This literature usually calls actors with low constraint brokers; in our case, we only call brokers users who send messages that are relevant for both movements, regardless of their level of structural constraint. This allows us to differentiate the possibilities for information flow created by the network from the actual flow of information in which users engage.

By identifying the brokers and analysing their relation to the underlying network structure we can locate bridges across movements. However, constraint is a local measure, and many of the structural holes identified through it might not be separating the two movements but creating internal fault lines. To explore this possibility, we make use of community detection algorithms, which partition the network in groups according to patterns in the density of connections. The assumption is that users that are part of the same group will have more links connecting them than to users classified in different groups. This bottom-up approach offers a way of identifying communities in a network using the network structure itself. As explained above, the content of the messages allowed us to classify users as mostly Occupy or mostly ‘indignados’; community detection helps us find groups based on the patterns of connections that users build rather than on their protest-specific communication.

One of the classic methods for community detection uses the betweenness of edges in a network (Newman, 2012). This measure identifies which connections fall in more paths connecting any two nodes; the paths in a network are the number of links that need to be crossed to go from node $i$ to node $j$ – in Twitter, this would be the number of intermediaries between two users that are not directly connected, or the degrees of separation between them. By removing the edges that have higher betweenness scores first and counting the number of communities that emerge as a result (that is, the number of unconnected sub-networks that result from the removal), and iterating the process until there are as many communities as nodes in the network (i.e. all edges are removed), this method finds the best partition to classify nodes in
groups that are internally densely connected. The best partition is the classification that maximises the modularity score, a coefficient that quantifies the strength of community structure by measuring how separated the groups are from each other. This score measures the fraction of all edges in the network that connect nodes in the same group minus the expected value of that fraction in a network with the same classification but random connections. The score is calculated as

\[
Q = \sum_{ij} \left( \frac{A_{ij}}{2m} - \frac{k_i \ast k_j}{(2m)(2m)} \right) \delta(c_i, c_j) = \sum_{i=1}^{c} \left( e_{ii} - a_i^2 \right)
\]

where \( m \) is the number of edges in the network, \( A_{ij} \) is the cell in the adjacency matrix specifying whether nodes \( i \) and \( j \) are connected, \( k_i \) is the degree of node \( i \), \( c_i \) is the community or group where node \( i \) is classified, \( c_j \) is the community where node \( j \) is classified, and \( \delta(c_i, c_j) \) is 1 if \( c_i = c_j \), that is, if nodes \( i \) and \( j \) are classified in the same group, 0 otherwise. The modularity score equals thus the fraction of edges that have both end nodes grouped in the same community \( i \) \((e_{ii})\) minus the fraction of all edges with at least one end node in the same community \( i \) \((a_i)\). If the number of connections within groups is no better than random, the result of this calculation is \( Q = 0 \); when the score approaches \( Q = 1 \), the evidence that the network has a community structure becomes stronger. In practice, most values fall in the range from 0.3 to 0.7, which higher values being rarely observed (Newman & Girvan, 2004).

Betweenness methods, however, have high computational costs and are not efficient for networks that have more than a few thousand nodes. We apply instead three alternative methods that are designed for large networks, but have the same aim of identifying groups in a network using the structure of connections: fast greedy community detection (Clauset, Newman, & Moore, 2004), label propagation (Raghavan, Albert, & Kumara, 2007), and mapping based on the probability of information diffusion (Rosvall & Bergstrom, 2008; see also Csárdi & Nepusz, 2006 for details on implementation of these methods). The first two methods improve the algorithms to save the memory and time involved in the calculations, but they are still based on the assumption that connections should be denser inside groups than outside groups. The information mapping approach, by contrast, introduces a conceptual change by identifying communities not on the basis of patterns of connections, but on how those connections allow information to flow. Unlike the other two methods, it takes into account the directionality of links and it does not rely on an implicit model of network formation (there is no benchmark derived from a random formation of links). Our analyses compare the consistency of these three classifications, and their relation to the partition derived from the content of the messages (i.e. mostly Occupy, mostly ‘indignados’). We calculate and compare modularity scores according to formula (2) for each of these classifications.

The analyses that follow from these methods aim to shed light into the potential breaking points that threaten the global connectivity of the protest communication network. Its robustness will be further tested with simulations that
remove targeted users (according to their level of constraint, and to whether they are information brokers) and compare the number of resulting components with what would emerge if users were removed randomly. This test will complete the picture of how dependent the network is on the bridges that protesters themselves build.

5. Analysis I: Brokers and Bridges

Information brokers bridge the two movements by sending messages that are relevant to both audiences. As Figure 1 reveals, these users tend to span more structural holes in their local networks: their constraint (eq. 1) is lower, which means that they are connected to other users that would be disconnected without their mediation. Brokers are also significantly more active in the contribution of messages, and more visible in the stream of information: they are re-tweeted and mentioned more often than non-brokers. The outliers in these boxplots were removed, hence the short scale of the vertical axes: the maximum number of messages sent by a unique user is 8,950, and the maximum number of RTs and mentions are 3,930 and 1,475, respectively. In this network, 1% of users send 37.5% of all messages; these users are the outliers that were removed from Figure 1 (most of them were also information brokers).

Figure 2. Differences between Brokers and Non-Brokers

That brokers have more access to structural holes might mean that they are bridging the two protest communities; but constraint is a local measure, and the community structure of the network depends on the global assembly of connections; structural holes might also open within the boundaries of the two main protest groups. If we use the classification of users as mostly ‘indignado’ or mostly Occupy to partition the network, based on the content of messages, the resulting modularity score is $Q = 0.446$, which means that users in these two groups tend to be more densely connected to each other than to users in the other group. Figure 3 displays the modularity scores associated to the three community detection methods described in the previous section, as well as the size and composition of the top 5 communities that result from each method.
The three methods give a more fine-grained picture of the communities that form this network, in particular, of the subgroups that exist within each side of the structure of communication. According to the label propagation method, the network can be split in 61 communities, although 99.8% of users are classified in the top 5, depicted in the figure. The fast greedy approach results in 123 communities, although again a high percentage of users (99.6%) are assigned to main 5 communities. Finally, the information mapping approach departs more significantly from the other two: it results in a higher number of communities, with the top 5 containing just above half of all users (53.2%). This departure is not surprising given that the method, as explained in the previous section, takes into account the directionality of links and assigns users to communities depending on how easy information can flow among them, rather than on how the density of connections within and across groups compare to what would be expected by random chance. This information flow approach offers interesting insights into how the network operates: each side of the protest is split up in more groups than their main affiliation might suggest when it comes to facilitating the flow of information. More communities means that there are more fault lines in the network, or weak points that can put its global connectivity at risk.

In spite of these differences, the three methods offer a similar picture of the divide across ‘indignados’ and Occupy protesters; in the three cases there is also a small subgroup of Occupy users that play a special role in mediating the connections across that divide. Information brokers, however, are represented in most of these groups. Although the second method (fast greedy) results in a slightly higher modularity, the three approaches improve when compared to the two-group partition based on the content of messages. This confirms the idea that a bottom-up, topological approach to community formation offers a more detailed account of connectivity and potential split lines in the network.
If we take the fast greedy classification, the number of connections bridging communities amounts to 5.23% of all ties in the network; about 10.5% of the users that create those bridges are information brokers. This suggests two things: first, that brokers are crucial to this network not only because they help keep the structure together (by reinforcing connections across communities that would otherwise be apart or more separate); and two, that there is a large number of users spanning the holes across communities that do not engage in communication relevant for the two sides of the protests, which limits the ability to diffuse information. These findings put in perspective the assumption often made in the literature that online networks are very efficient in the spread of information; the data suggests that in fact protest networks are divided in ways that can hamper diffusion and even put the global connectivity of the network at risk.

6. Analysis II: Network Robustness

The question that follows from the previous analyses is: How important are information brokers to keep the network together? Does their position in the network help improve global connectivity? In order to test the role of these users as the glue of the network, we run a number of simulations with the largest component, removing users randomly or according to two attributes: their structural constraint and their classification as brokers. As mentioned above, not all low-constrained users engage in dual communication, but all brokers tend to have a low structural constraint. If, by removing them, the network starts to break into separated components, we can take that as an indication that those users where spanning important holes in the network. Figure 4 summarises the results of these tests.
Figure 4. Robustness of the Network to the Removal of Nodes

The plots on the first column track the number of components (vertical axis) that result as a percentage of users that are progressively removed from the network (horizontal axis). The red line corresponds to the removal of users according to their constraint, starting from the lower percentile of the distribution (transformed to the logarithmic scale, which makes it approximately normal); the black line corresponds to the removal of the same number of nodes, but picked up randomly. The plots on the second column summarise the results of a similar exercise, only this time the red line tracks the removal of nodes that are classified as information brokers. What the figure shows is that, as one would expect, the higher the percentage of users removed, the more components emerge. However, the difference from the random benchmark is greater for brokers: overall there are less components because the absolute number of users removed with each percentile point is lower, but removing those brokers seems to have a more significant effect on overall connectivity, compared to the random selection, than the removal of nodes according to their constraint.

The bottom plots zoom into the first tenth of the scale to allow examining in more detail the moment when the initial single component splits up. Removing 0.1% of the users in the lower tail of the constraint distribution suffices to break the
network into 21 separated components; a random selection of the same number of
users generates an average of 3 components. With brokers, the effect of removing
nodes does not depart from randomness until 3% of these users are deleted: there is
then a sudden increase in the number of components \(M=12\), compared to the
random benchmark \(M=5\). This reinforces the previous conclusion that the global
connectivity of the network, and the ability to communicate across sub-communities,
relies on a small number of users.

Having a small number of nodes bringing together a network of this size is,
from an engineering point of view, a rather efficient arrangement: it lowers the
amount of resources that are required for maintenance, and is in principle more
resilient to random failure. Random, in this case, is a black box for the myriad reasons
why a user might decide to stop contributing to the flow of information. And
obviously, online networks are in constant change, mostly in the direction of growth,
which means that testing the resilience of a network without factoring in new
connections is, in a sense, a biased exercise. However, what these analyses reveal is
that online networks can be as vulnerable and fragile as fluid and adaptable: even if
nodes are constantly added, because these networks are complex structures that defy
central planning it is difficult to allocate those new resources where they are most
needed, for instance, bridging a structural hole. And there is path dependence:
acquiring a certain network position takes time, which reduces the ability of these
networks to adapt to changing circumstances. Even if new connections are created in
the right locations, the flow of information still requires brokers allowing the
information to travel from community to community; and the data analysed here
reveals that not many of the users involved in online communication fulfil that role –
not even those who are in the right network position.

6. Discussion and Conclusions

The study of contentious politics in the digital age abounds on network talk,
as recently expressed in influential theoretical accounts of political protests under the
rubric of “the logic of connective action” (Bennett & Segerberg, 2012) and
“networked social movements” (Castells, 2012). This paper has argued that, to
advance in that theoretical discussion, the language of networks has to be geared
towards empirical work that can analyse the way in which online communication
actually operates. This requires working on a different level of abstraction from that
where those theoretical approaches have been developed. A more nuanced and
analytical methodology is required to disentangle the ways in which communication
networks let information flow – or trap it within the boundaries of local communities.

The analyses above have identified several fault lines across and within the
Occupy and ‘indignados’ movements: they suggest that global connectivity can be
hampered by two types of structural holes, internal and external. Even when users
span those holes, they don’t always engage in communication that can bring local
streams of information together. Only a minority of users fulfil that brokerage role,
and they tend to concentrate most of the action in the network, both as content
producers and as targets for the messages sent by other users. This translates into a
network that is far from the horizontal structure often described in the literature as
quintessential to digital protests. Talking about horizontal structures can be useful as shorthand to refer to decentralised organisations, but not to analyse the process by which these organisations materialise in communication networks. The distribution of users in those networks reveals a strong hierarchy in terms of connections and the ability to communicate more consequentially.

These conclusions are based on a sample of Twitter activity that makes our estimates fall on the conservative side. The search API is better at capturing activity at the core of the underlying network of full stream, which means that our sample is capturing the most salient activity but it is most likely undermining the centrality of the users involved because the sample is not as good at mapping peripheral users (Gonzalez-Bailon, Wang, Rivero, Borge-Holthoefer, & Moreno, 2012). Had the sample been larger, the network would have probably had more paths forging global connectivity, but those paths would have also been more difficult to find or activate for the actual flow, given the low percentage of users that act as brokers.

More work needs to be done to uncover the mechanisms that drive the diffusion of protest information, and how those dynamics relate to the constraints imposed by time (including how long it takes for users to react to new information) and geography (through the physical borders that still contain much online activity). The data and methods presented in this paper help assess the extent to which new technologies allow local protesters to engage in global networks of communication; they also allow identifying the users that control that flow and create the bridges linking local communities and groups. This helps examine the robustness of online networks, and their alleged fluidity and ability to adapt to changing circumstances. In brief, this paper gives reasons why we should revise common assumptions in the study of contentious politics on the digital age, and evaluate them through the lens of what protesters actually reveal through their actions.

References


Appendix

Table A1. List of Top 100 Hashtags in the Sample of Messages Analysed

<table>
<thead>
<tr>
<th>Rank</th>
<th>Hashtag</th>
<th>Frequency</th>
<th>Rank</th>
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Table A1. List of Top 100 Hashtags in the Sample of Messages Analysed (c’ed)

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The Bridges and Brokers of Global Campaigns in the Context of Social Media

Sandra Gonzalez-Bailon
(joint work with Ning Wang)
sandra.gonzalezbailon@oii.ox.ac.uk

Social Media and Political Participation
May 10, 2013
Political Mobilisation in the Digital Era

• ‘networked social movements’
  Castells, M. (2012). *Networks of Outrage and Hope. Social Movements in the Internet Age*

• the logic of ‘connective’ action
Political Mobilisation in the Digital Era

- ‘networked social movements’
  Online networks “transcend time and space”

- the logic of ‘connective’ action
  Online networks “transcend the elemental units of organizations and individuals”
‘indignados’ and Occupy Timeline

May 2011
‘Indignados’ arise

July 2011
AdBusters OWS call

September 2011
Wall Street Occupied

October 2011
United for Global Change protest day

October 2011
United for Global Change protest day
Previous Work on ‘indignados’

Recruitment over time

Size of information cascades

Position of Recruiters

Position of Spreaders

González-Bailón et al. (2011). The Dynamics of Protest Recruitment through an Online Network, SciRep, 1, 197
Previous Work on Occupy

## Network Statistics

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<td>(\text{max}(k_{out})) (maximum outdegree)</td>
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<td>(N) 2(^{nd}) largest component</td>
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Information Brokers

N=8,082

N=51,212

N=74,007
Distribution of Users in the Network

- Ratio following/followers
- Ratio messages received/sent

Counts: 19000, 9500, 1
Distribution of Users in the Network

- ratio following/followers
- ratio messages received/sent

counts

visibility

size of audience

broker
non-broker

10^{-4} 10^{-2} 1 10^{2}

19000
9500
1
Structural Holes and Communities


The Network Position of Brokers

- Structural constraint
- Messages sent
- RTs received
- Mentions received

Comparison between non-broker and broker categories for each metric.
Communities in the Network

label propagation

fast greedy

information mapping

$N_{top5} = 124,957$
$M = 61; Q = 0.544$

$N_{top5} = 124,696$
$M = 123; Q = 0.549$

$N_{top5} = 66,678$
$M = 4,241; Q = 0.518$

- mostly occupy
- mostly ‘indignado’
- % percentage of brokers
Network Robustness – Constraint

![Graph showing network robustness](image)

- **Red dotted line**: constraint
- **Black line**: random
Network Robustness – Brokerage

The diagram illustrates the number of components in a network as a function of the percentage of users removed. Two scenarios are compared: brokers and random removal of users. The graph shows that the number of components increases significantly when brokers are removed, indicating a higher network robustness compared to random removal.
Conclusion & Discussion

• Online protest networks are not as global, fluid, or robust as claimed

• More research is needed to uncover network mechanisms driving the diffusion of protest information