Technopolitics: the potential of connected multitudes.
The 15M network-system as a new paradigm of distributed politics.

This text is a synthesis of our study on a living and novel phenomenon under construction. For more than six months our group, DatAnalysis15M, has undertaken a systematic exercise of analysis, synthesis, and visualization of data from the Spanish 15M (also known as "indignados") movement. The work, summarized here[1], explores a series of theoretical and methodological proposals for the study of 15M and similar movements.

In our investigation, of transdisciplinary character, we have developed and applied new analytical methods based on complexity sciences, network analysis and data engineering in order to approach social movements in the network society, as well as to improve collective action inside them. In this sense, we have approached the movement from the viewpoint of both research and action.

We are convinced that we are in the prehistory of the network society. Despite the fact that the beginnings of microelectronics date back only to the last third of the XXth century, the last fifteen years have been crucial in the evolution of the Internet, free software, mobile devices and social networks, among other information and communication technologies (ICTs).

This process is not merely technological but also social or, rather, sociotechnological. Our study shows that the use and appropriation of different platforms or devices as enablers of political action have been key to 15M. The concept of "technopolitics" (which we dig into later on) connects the different research lines of a work that, more than a study, represents the sketch of a research program.

1. Introduction.

The starting point of this work is the combination of the personal experience and the intellectual inquisitiveness of a group of activists and researchers in the face of an extraordinary phenomenon such as 15M, for whose comprehension—in our opinion— we lack appropriate conceptual frames and methodologies.

In our exploration of 15M technopolitics we have combined quantitative and qualitative methodologies. Many of the methods used in this study are characterized by their strong mathematical and empirical components.

The complexity of the phenomenon invites us to initiate an analysis using concepts elaborated in previous investigations on the relationship between social movements and

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[1] A full version of the study can be found here
http://in3wps.uoc.edu/index.php/in3-working-paper-series/article/view/1878

new information and communication technologies (Castells, 2009). Other studies have analyzed new social interactions in the digital sphere (Shirky, 2008) and within new social movements in the time of the Net (Bouechler, 1999). On their part, authors such as Howard Rheingold (2004) have analyzed the beehive intelligence or mind that, according to them, emerges in processes of collective mobilization mediated by ICTs, generating what he calls "smart mobs". More recent studies show that the Internet offers key advantages for activism, since it reduces protest organization and participation costs, while it diminishes the centrality of physical proximity for collective action (Earl and Kimport, 2011).

It is necessary to add to those investigations others centered on the Arab Spring, Occupy and 15M itself, which analyze the relation between these mobilizations and social media. In this sense, it is of interest to consider studies that have linked these movements to network analysis and the network form (Borge-Holthoefer et al, 2011; Lotan, 2011; Lucas, 2011; Morer, 2012). Some such studies have attended to linguistics (Lindgren, 2011), while others have connected social sciences with complex system analysis (Boccaletti, 2006) and emerging systems of collective behavior (Stevenson, 2002).

Sociological approaches tied to the tradition of complex system analysis provide new theoretical and analytical frames for studying processes of self-organization in the network society. They allow detailed analysis of how processes of networked communication are coordinated at different temporal and spatial scales to constitute themselves as coherent units able to modulate complex collective behaviors. They also make possible to differentiate several types of social mobilization and self-organization mediated by ICTs. In our work we have tried to deepen and go beyond notions such as "smart mobs", "new social movements" or "networked social movements".

In order to rethink many of these ideas, we propose the notion of "technopolitics", defined as the tactical and strategic use of technological devices (including social networks) for organization, communication and collective action. At the same time, we differentiate this concept—and the practices it tries to cover—from cyberactivism (Tascón and Quintana, 2012) and clicktivism. Technopolitics can connect to cyberactivism insofar as collective action is limited to the digital sphere; nevertheless, in a full sense, technopolitics points towards a series of collective practices that can take place or start on the Internet, but that do not stay there. 15M technopolitics has manifested itself as an occupation of the public space (in the physical, digital and media sense) able to orient distributed actions in the city as much as online. Online social networks have not only served to construct or coordinate collective action but, especially, to construct the sense of the actions themselves, and generate a transformative impulse across society.

The study distinguishes five periods in the development of 15M, from April 2011 to June 2012:

-From May 16th to June 19th, 2011. Explosion-Stabilization.

-From June 20th to September 16th, 2011. Latency.

-From September 17th to October 15th, 2011. Globalization.

-From October 16th, 2011, to June 20th, 2012. Evolution-Mutation.
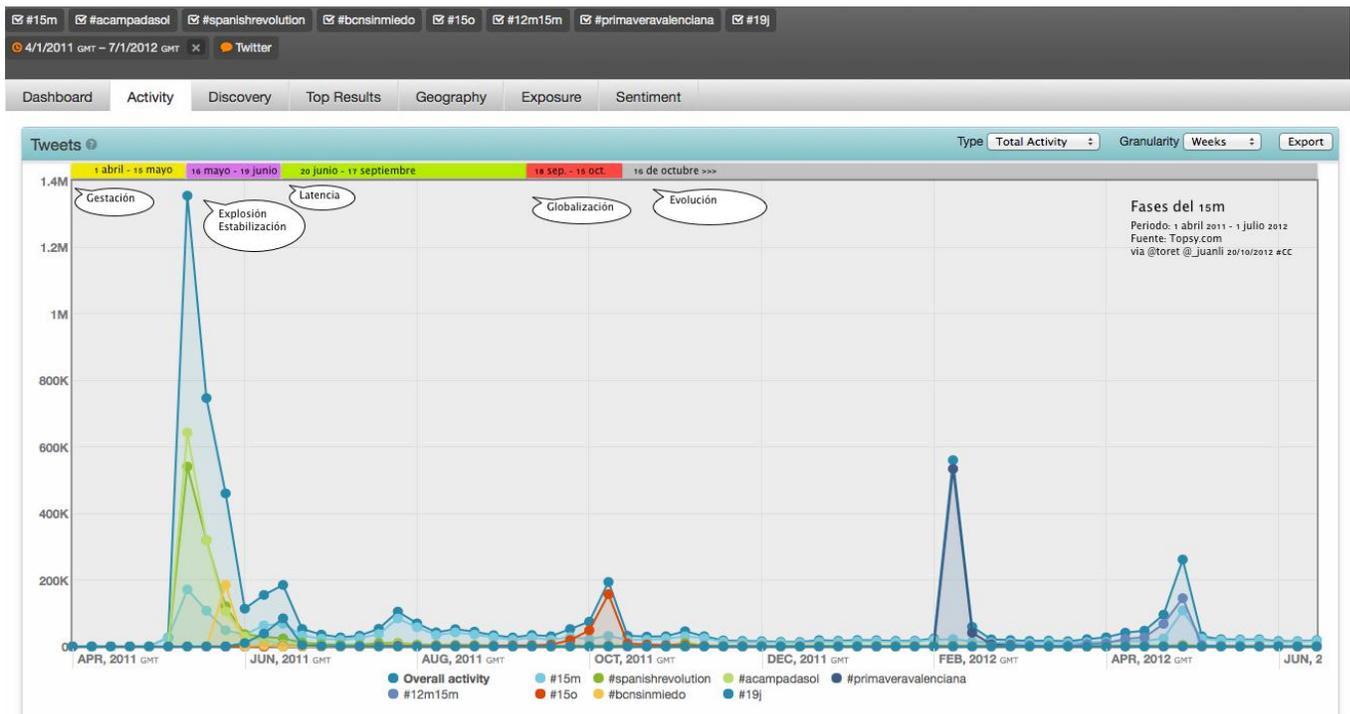
Topsy graphic with 15M stages and its activity peaks. Elaborated by Joan Linares and Javier Toret.

2. Gestation, antecedents, and triggers.

In order to understand 15M it is necessary to attend to the different factors and influences that preceded the demonstration of May 15th, 2011. These factors and influences detonated the citizen response on the Internet and on the streets.

Our study shows that, in the emergence of 15M, there was an accumulation and combination of differential historical, political, and subjective conditionings, such as the gestation of what we define as a "critical mass" resulting from the struggles for Internet freedom in the period 2006-2011 and the popularization of the technopolitical practices

associated with them. This was combined with a situation of economic crisis and increasing citizen distrust towards institutions of political representation, resulting not only from the economic crisis but also from other factors, such as the institutional reaction to the situation and the revelation of numerous cases of corruption. That said, the relevance of that critical mass online and its associated practices in the rise of the movement cannot be underestimated. This is easy to understand if we think that, in countries such as Italy, Portugal, or Greece, culturally not far from Spain and under similar conditions of economic and social degradation, no movement with 15M's form, force and impact emerged during the same period.

Connected to these factors, the technologically structured emotional mobilization that defined 15M's beginning had two main sources: the contagion or resonance produced by the Arab Spring and the construction, by the mentioned critical mass, of a technopolitical, viral, inclusive and empowering campaign.

In schematic form, three elements marked the genesis of 15M:

- Struggles for a free and neutral Internet: in the Spanish State, between 2006 and 2011, a critical mass coalesced around topics such as the free exchange of files, Internet freedom and the defense of online sharing.

- Technopolitical practices: the technological and social critical mass, in the shape of a connected multitude, extended different strategies and tactics for communication, organization and collective action mediated by technologies.

- Arab Spring: the images of Arab uprisings, broadcasted by communication media, as well as those diffused by the Internet, empowered the watchers and situated in the collective imaginary the possibility of political revolt.

Our study collects evidence indicating that, during the period from May 15th to mid-June, there was a massive diffusion of technopolitical practices. There was also a popularization of different strategies and tactics for using digital networks, and the creation of collective identities for gestating, organizing and providing meaning to political actions.

Available data show that Internet traffic at the country level rose by 17% from April to May of 2011. There was an exponential increase in: the number of new Twitter users, the volume of tweets and Facebook activity, the number of front pages in the news site meneame.net, and the number of users in the free and self-managed social network n-1 (from 3.000 to 40.000 in one month). The relevance of the Internet is also made clear by the fact that 94% of the people that attended the demonstration on May 15th had a profile in a social network. Out of the total of 6.0-8.5 million people estimated to have participated in the movement, 96% participated through Facebook, 66% in assemblies and camps, 45% on Twitter, 34% in neighborhood assemblies, etc.

On top of numerous testimonies compiled in interviews, documentaries, and texts, our study incorporates quantitative analyses showing that 31% of Twitter profiles that used the hashtag #Spanishrevolution had used the hashtag #Nolesvotes previously. These findings reinforce the thesis about the relevance of the critical mass that constituted the struggles in and around the Internet in the years before 15M.
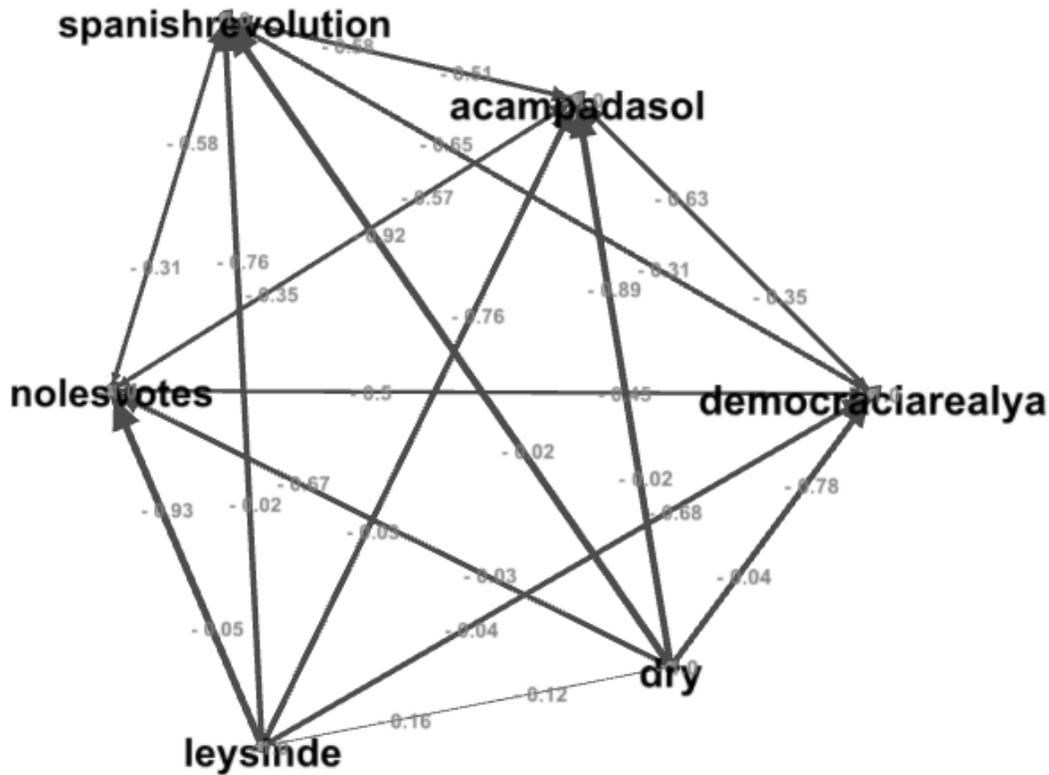
Graph of the relation between different hashtags, obtained through the technique of hashtag flocks. By Alberto Lumbreras.

3. 15M as augmented event.

15M technopolitics can be conceived as an example of self-organization in the network society, linking political innovation and technological innovation; it embodies a social and political appropriation of technology. In this sense, 15M is a physical and post-media event that is pre-lived in the virtual realm, which unfolds sequentially from the Internet to the street and the square, in a feedback loop between collective action in the city and social networks in the cyberspace.

Against the mass media silence from May 15th to 17th, in social networks (specially Facebook and Twitter) there were thousands of images, comments, and narrations of what was happening all over the country. The dissonance between mass media and the

processes on the Internet and on the streets was clear. Information propagated from social networks to collective news online sites, blogs, digital newspapers, and even international media. This represented the break of the monopoly of agenda setting by mainstream national media, which were forced to report on it. 15M opens the way for the intentional influence of citizen networks into mainstream media, through the circuits of global information.

Previously, the campaign "Take the street", initiated by the citizen platform "Real Democracy Now!" had reached thousands of people through social networks online and offline without any mass media or institutional coverage whatsoever.

The eviction, on the early morning of May 17th, of the recently taken Puerta del Sol, was broadcast live by amateur streaming across different social networks. The eviction, along with the retaking of the square a few hours later, constituted an augmented event: the distributed signal of the nascent 15M network-system, with the aid of the Internet, was amplified when inserted in the mass media circuit, at the national and international level. This brought hundreds of people to Sol.

The concept of "augmented event" results from joining the notions of "augmented reality" and "event". In this case, the augmented event around May 15th generated the 15M network-system as a constellation of organization forms on the physical and the digital layers, which try to give meaning and extend their potency through a collective transmedia narrative.
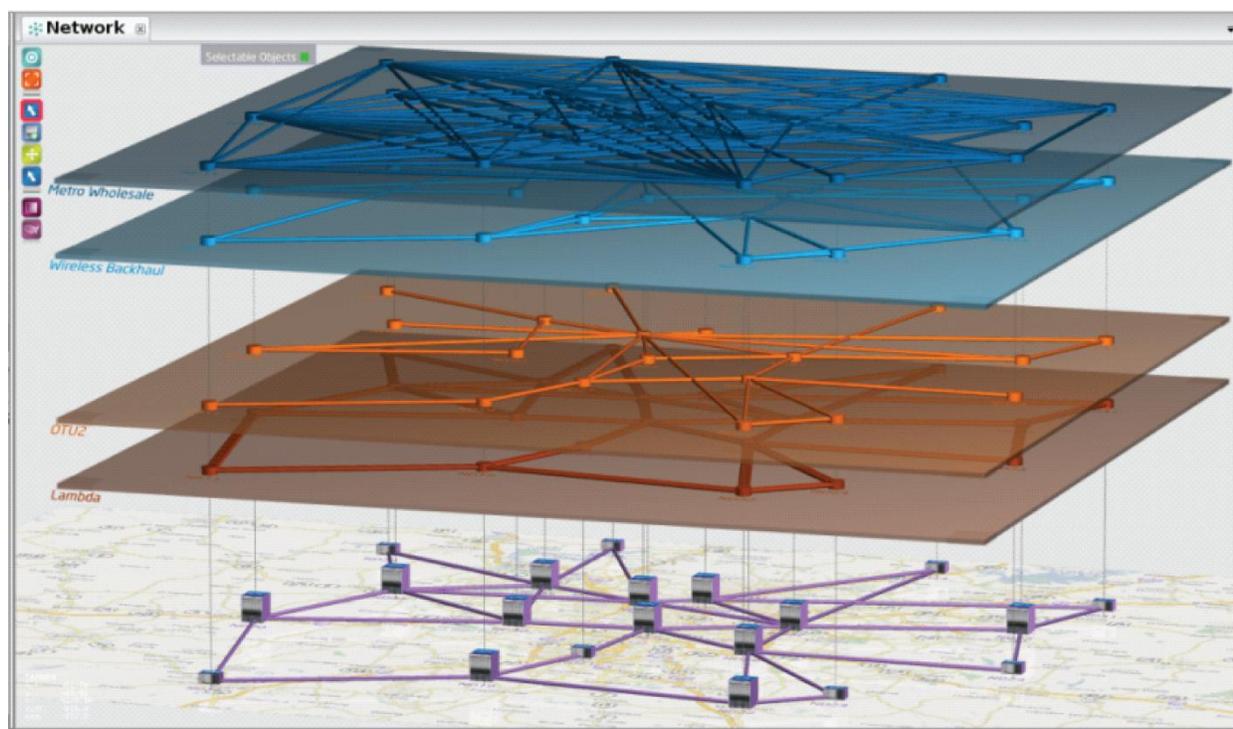
Multi-layer system: streets, Facebook, Menéame, Twitter, Massmedia.

The event (by getting articulated with different mass self-communication media) augmented the networks that nurtured it, extending and developing lived experience and action both in the media and in the cities. In this way, it was linked to the constitution of a connected multitude under the network-system form (we analyze the notion of network-system below).

4. The emotions and the vocabulary in 15M.
4.1. Analysis of emotions.

The economic and institutional crisis and the existence of a movement online wouldn't have been enough to generate 15M. This type of phenomena do not emerge from poverty or political despair only, they require a big emotional mobilization, as explained by Manuel Castells in his recent work "Networks of Outrage and Hope". A spark is needed, an impulse or trigger that is not material but, primarily, affective in character.

According to our study of emotions in 15M on Twitter, the tweets calling for the demonstration on May 15 already showed a high emotional charge, but what made the movement explode was their feedback with the emotions on the streets and the squares. 15M has shown a great capacity for constructing connected and empowered moods through technologies and strategies for collective action between the Net and the street. In this sense, technopolitics has facilitated, thanks to its performative power and its inclusiveness, the capacity to connect to the world, to believe in our power for affecting and transforming it.
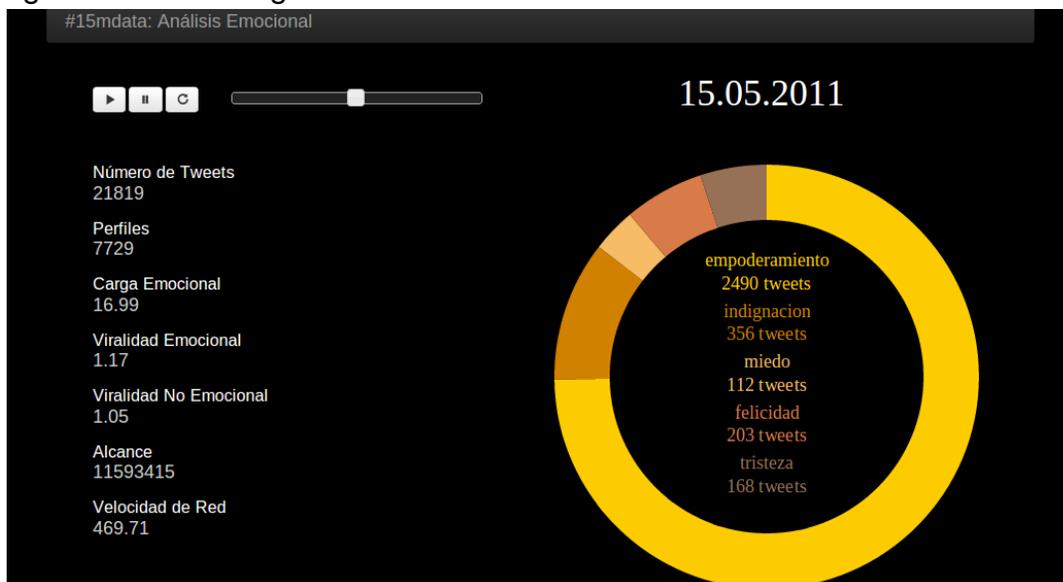
Emotions viewer, from May 15th 2011. By Oscar Marín Miró.

Starting with these hypotheses, an analysis has been conducted of the emotional charge of 15M's language on Twitter. The analysis is based on a set of more than a million tweets collected between April and June 2011 that included 15M hashtags. We have used a corpus of annotated words, associated with specific emotions, in order to study collective emotions conveyed by the messages.

The more relevant results from this study of emotions are:

- 15M tweets have more than double of emotional charge than "normal" tweets, with peaks close to 20% and an average of around 13%, far from the 5.4% of the total of the tweets geolocated in Spain (the percentages indicate the proportion of messages containing the emotionally connoted words).

- Virality metrics[2] indicate the occurrence of a viral explosion in mid-May, coinciding with a period of social and media agitation and strong emotional charge (around 15% on average).

- Empowerment and indignation are the predominating emotions, which operate as an activation base for action.

- The emotional charge reaches its highest peak during the first weeks of May 2011.

These results reveal the centrality of emotions in the explosion stage of 15M, since they potentiated its condition (its virality) as augmented event. Moreover, we could say that empowerment and indignation formed an emotional binomial that provided energy to the emerging 15M network-system.

4.2. Analysis of 15M vocabulary

Connected to this emotional explosion around May 2011, a new and cohesive vocabulary emerged among the people participating in the events. Between May 15th and 29th, everybody in 15M networks is speaking of the same, using words that appear frequently and connected among themselves. This is what results of 15M vocabulary analysis, carried on by Oscar Marín Miró, indicate. With his analysis we can see the state of the concept network or mental cloud of 15M every four days. We can observe the recurring concepts and how they relate among themselves but, above all, it is interesting to appreciate the cohesion of the vocabulary.

We have also detected that, during the second week of May 2011, a "revolution" in the "15M message" takes place: vocabulary is created and shared at a high speed, increasing its "temperature", that is, the "rhythm" at which new words appear. This kind of increases in temperature take place around events such as the prohibition, dictated

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[2] We distinguish emotional virality (fraction of tweets that are both retweets and have an emotional tag relative to the total—tweets and retweets—in a given temporal window) and non-emotional virality (fraction of tweets that are retweets, relative to the total, in a given temporal window).

by the "Electoral Junta", of all demonstration on the squares during the day before the local and regional elections of May 22nd, or the brutal attempt at evicting Plaça Catalunya on May 27th. This is a period when messages are very new relatively to the previous period. Curiously, the cohesion of vocabulary remained very high.
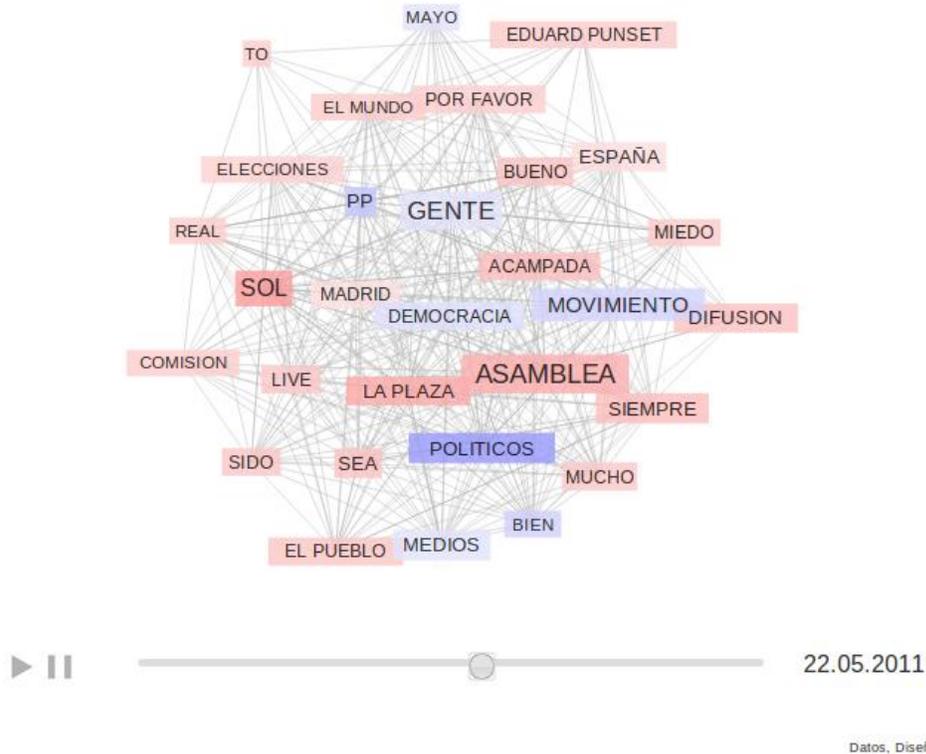

Network of the most used words in 15M tweets (in the figure, the data from May 22nd). Links connect concepts that appear more frequently together in tweets of the analyzed sample. By Oscar Marín Miró and Outliers.

5. The network-system concept

Up to this point we have used the concept of network-system without offering a sufficient definition of it. Our study presents 15M, understood as a network-system, as a set of heterogeneous nodes with high indexes of connectivity, robustness and reciprocity, whose structure is open and polycentric. This is an emerging system, self-organized and autonomous.

In our study we try to clarify the differences between conceptualizations of 15M, especially, those that present it as network-movement, as climate and as network-system. We show that 15M is more than a social movement and suggest that the notion of network-system offers more opportunities for operationalization and quantitative analysis than alternative conceptualizations.

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Analyzing the network topology of 15M, we have found an abrupt growth soon after May 15th. The movement structured itself between the physical and the digital space. The 15M network moved from 3.403 nodes in the days before 15M to 110.198 during the explosion stage. The network of camps-squares also grew exponentially in the first weeks of the movement.
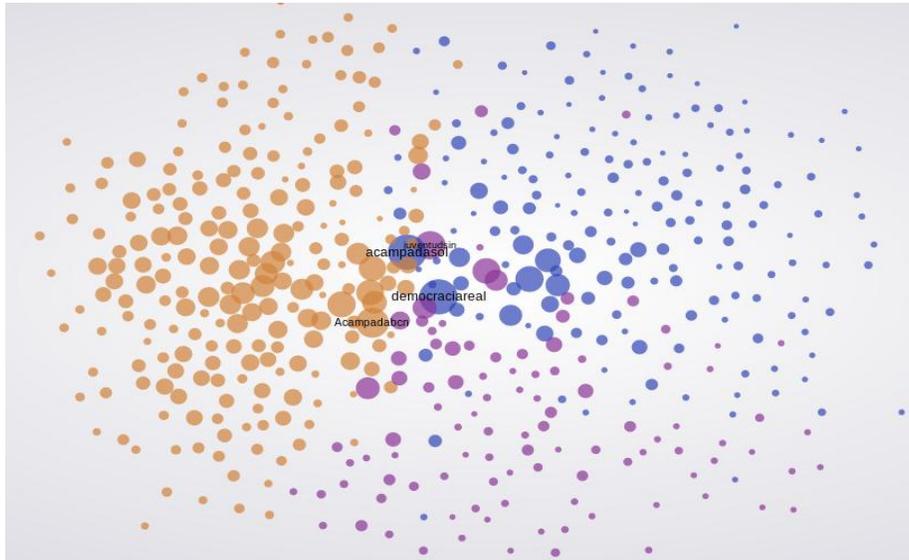
Map of the 499 accounts for following the #spanishrevolution, by Manuela Lucas, available at http://www.manuelalucas.com/sre/

The network-system in its activity peak manifested itself as a reality-producing machine that disputed the enunciation and legitimacy of constituted powers: a *counter socius*, a social body as immanent plane (Deleuze and Guattari, 2006), defined by the flux of shared desire among those who were connected. This social body displayed an emotional and cognitive autonomy proper of a new subjectivity. It is an example of a new social body struggling to emerge and manifest itself in a postcapitalist world, in full form and in defiance of the ongoing suppression of the commons (Negri and Hardt, 2005; Pal Perbart, 2009).

6. 15M networks' topology.

In our exploration of 15M as network-system we have made use of network topology analysis. For that we have extracted Twitter data corresponding to several stages or periods of 15M, each of them tied to activations of the system around events.

In the gestation stage, between April 1st and May 15th, 2011, there was a remarkable presence of collective accounts belonging to two of the platforms organizing the demonstration on May 15th. Also remarkable (and something exclusive of this stage) was the presence of renowned users on Twitter, such as the social and political satire El

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Jueves. This fact is explained by the small set of data (corresponding to retweets produced in two days only) and the absence of identities proper of 15M, as this was a formative stage—it can be recognized as such, precisely, by this absence.

In the explosion stage (from May 16th to June 19th, 2011), when the 15M network-system structured itself, there was a rise in the number of collective accounts as important nodes in 15M diffusion networks. This tendency is accentuated in the stages of globalization (from September 17th to October 15th, 2011) and anniversary (around May 15th 2012) where the list of the most important accounts on Twitter was composed by a majority of collective accounts generated by 15M and the Occupy movement. In fact, the Real Democracy Now! appeared as the essential node in all the stages of the study, as did the accounts Sol Camp and Barcelona Camp after the 15M explosion. The results also reveal the aggregation of important nodes to the network-system, belonging to accounts of collective identities born after 15M (such as @iaioflautas).

Diffusion network from the 15M explosion stage. Graph by Pablo Aragón.

Other results point to the high number of mass media and informers' accounts during the explosion stage. Moreover, there is also a notable difference between individual user profiles which appear in the stages of gestation and explosion and those found in the anniversary stage. In the first stages, the most relevant individual user profiles correspond to people connected to the struggles around Internet freedom and the organizing platforms, such as Real Democracy Now! and #Nolesvotes. In the anniversary stage, the most relevant individual users correspond to users' profiles who occupied a key position after the first 15M year.

The presence of collective accounts as fundamental elements in the diffusion networks points towards the existence of a network-system of decentralized-distributed organization, without leaders or stable representatives. The shift in roles among individual users from organizers to key participants fits with a meritocratic model of organization, wherein the relevance of a node is determined by its activity and the received acknowledgement within the network-system—in terms of retweets, in this study. There was also a paradigm shift towards an organization model characterized by polycentric and distributed leadership across time, where physical people and traditional leaders play a secondary role.

7. Swarming.

The study of self-organized and intelligent collective behaviors, that is, the behavior of networks of people who mostly don't know each other and that, in spite of this, coordinate without a central authority, has pushed us to use the notion of swarming to explain phenomena characteristic of 15M in 2011.

We use a series of analogies with the animal world to understand the concept of swarming. As an example, ants' interactions through chemical signals allow them to coordinate their collective behavior. Flocks of starlings move as if they were a single body. These dynamics take place in the 15M network-system when there is a multi-layer synchronization of the collective behavior.

Examples of these phenomenon are the eviction of Catalunya square on May 27th, 2011 and the so called Valencian Spring, on February 2012. In both cases the use of mobile devices, streaming, Facebook groups and Twitter profiles in real time allowed collective self-organized actions between the Internet and the street. That is, information, attention and affects were concentrated and canalized thanks to multiple intertwined devices and system layers.

In both cases of swarming it is clear the actualization of the network-system under an augmented event, with the feedback between high emotional charge and processes of mass self-communication. The images of demonstrators' beaten bodies become intolerable and provoke a reaction. The duration and sequencing of these events, which accumulate emotional charge as they spread, are key for the formation of swarming phenomena. To the extent that the event endures (augments) in time and space, through different media and layers, it potentially captures the attention of more brains

and bodies. That facilitates participation and nurtures the forming of connected multitudes. At the same time, this capture keeps the event alive.

Finally, swarming generates a distributed and multilayered narrative that disputes the truth propagated by mass media and institutional actors. In this sense, the result is not only the propagation of a set of actions or images, but also truth-enunciates on the meaning of the events—which feedback with the events themselves.

8. Fractality and multifractality.

Fractality.

In order to better understand the networked social self-organization that has taken place in 15M, we have made use of the conceptual and mathematical tools used in the analysis of complex systems. The fractal[3] and multi-fractal analysis, which we present in detail below, are able to measure the levels of self-organization of the 15M network-system and to describe different types of synchronization of the activity of a given set of nodes.

The analysis is based on 15M messages on Twitter around May 2012, grouped and gathered around a series of hashtags used in a series of actions and campaigns. Using this set of messages as a sample, we have analyzed the correlations in activity frequency under every hashtag, in order to analyze to what extent the activity of the nodes taking part in the network was constituted as a coherent dynamic unity.

To that end, we have used a model called "F/1", which the cognitive sciences employ to analyze brain activity. In this case, we have applied it to what we consider to be the dynamics of 15M collective consciousness. There are three different kinds of noise, that is, of types of activity in a given process, which depend on the value of the parameter β:

- ($\beta < 1$): spontaneous and reactive, or white noise. These are processes of self-organization that are not able to maintain their identity in the long run. They are determined by the uncoordinated activity of the system nodes. They are highly unforeseeable and do not endure in time.

- ($\beta > 1$): planned and channeled, or brown noise. These are long-term self-organization processes, driven by the system as a whole, unable to capture attention and surprise, structured and predictable.

- ($\beta \sim 1$): equilibrated between the characteristics of the previous two, or pink noise. These are processes driven by the interaction between the nodes of the system. For these reason they are able to oscillate between spontaneity and mid-long term structuration.

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[3] A fractal is a pattern exhibiting self-similarity at different scales. This includes invariants at different scales of time (f. i., fluctuation in heart activity), space (f.i., structures in geography, anatomy or botany), or interaction (f.i., scale free networks).

According to our analysis, optimal processes of initiative propagation in 15M networks are characterized by the combination of the capacity to change and adapt with the capacity to maintain a stable identity over time. Successful processes—those that maintain their dynamic coherence for a longer period—equilibrate the influence of the different temporal scales in their activity; that is, they exhibit pink noise.

Processes where short or long term activity dominates the global dynamics, exhibit too much change or are too rigid to support effective collective action, and do not have the attractiveness of more versatile processes, which are able to find an equilibrium between short and long term activity. There remains an open question about how to construct processes with the characteristics of pink noise, or $\beta \sim 1$, even though the results suggest some hypotheses. The structure of pink noise processes indicates the relevance of connecting the different scales of activity of the system, as well as the presence of mesoscale (between the micro and the macroscale) able to connect the different levels of system activity. This hypothesis is especially important when we confirm that some of the processes exhibiting a pink noise configuration have been nurtured by "catalytic" groups, which strategically act to coordinate and modulate collective processes. They connect between local participation and the global dynamic of the process.

Multifractality

Fractality is not enough for characterizing the complexity of the 15M network-system, for this reason we propose multifractality measurements that calculate the level of coordination among scales of a system and the capacity of the system for dynamic self-regulation, combining periods of irregular behavior with periods of low variability.

Multifractal systems are measured by their fractal spectrum, more specifically, by its width. In this way we measure the presence of high and low variability periods, quantifying the influence of the coordination between the different temporal scales of the system.

Our multifractality study has focused on a set of hashtags used in 2012, specially, #29M, #12M15M, and #15MpaRato. For each of those hashtags the width of the multifractal spectrum has been analyzed, for time windows of 24 hours, starting at 6am in different consecutive days. The objective was to see the intensity of the coordination/self-regulation among the different users of each hashtag.

The results show how the network-system reaches high levels of multifractality in moments of intense collective debate ("take the strike" on 29M), when collective attention is focused on an event (#12M15M), or when there are catalytic mechanisms that modulate and amplify the activity of the system (#15MpaRato).

The fractality and multifractality measurements as a characterization of the type of

organization processes within the 15M network-system offer a very valuable tool for extending 15M's organizational forms, as well as for continuing the intense learning over processes of political communication in the network society. They allow one to think about the dynamic and non-linear nature of self-organization processes, which result from the continuous interaction between elements of the system, and not only out of the information content exchanged by the nodes.

According to the obtained results, successful self-organization processes (in terms of robustness, duration, cohesion, participation, etc.) exhibit pink noise and multifractal dynamics, as in the case of #15MpaRato. This suggests that activists' work is not only to construct adequate political programs but also to care for self-organization processes.
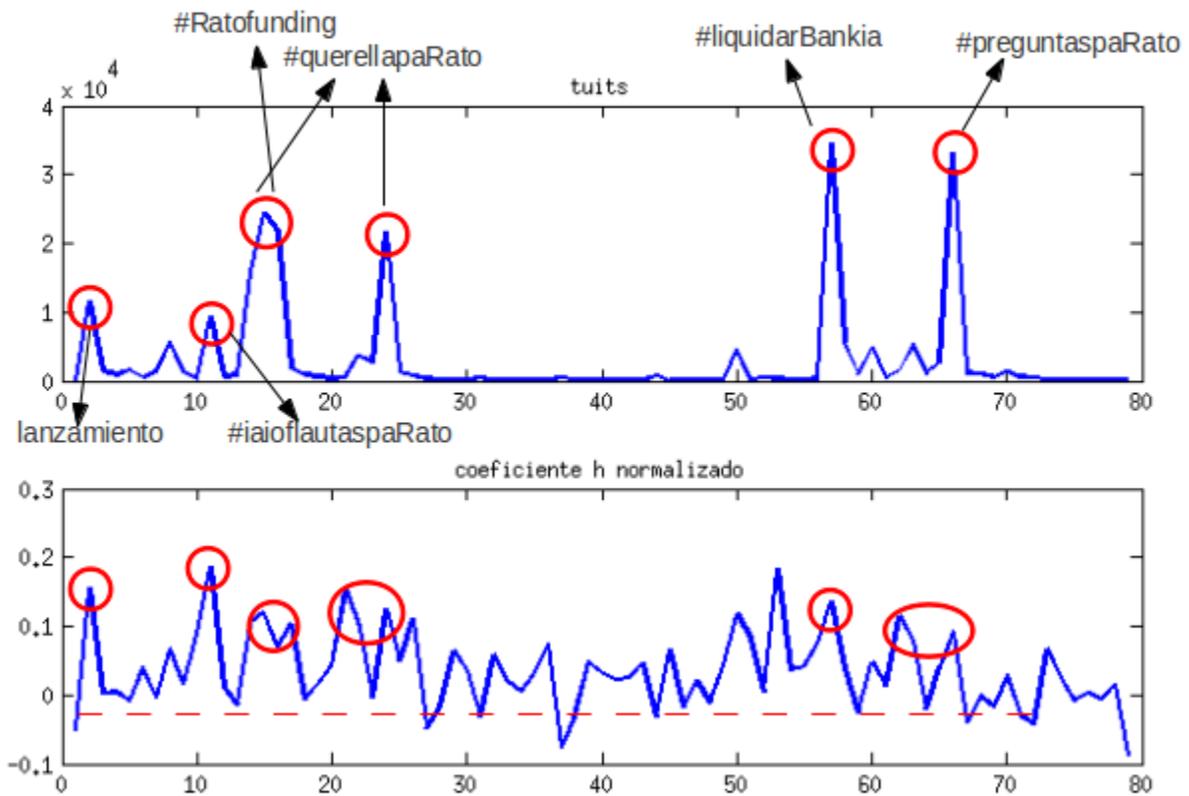
Graph by Miguel Aguilera. Peaks of multi-scale synchronization in the #15MpaRato case.

9. Provisional conclusions.

We have characterized 15M as the creation of a network-system based on a variable network topology, with mobile frontiers (defined, but mixing with the environment and reconfiguring with events), hybrid, cyborg (connecting machines, humans, virtual and physical entities) that constructs and reconstructs itself in sudden and ephemeral ways. Under certain circumstances, it manifests itself in sequences of activation and action that generate a connected multitude, a collective body that endures through time and can extend itself in space.

Based on these results, we offer provisional conclusions in relation to 15M:

- The centrality of the connection between social networks on the Internet and human networks on the streets for the emergence of new forms of communication, organization, and collective action. This centrality has been crucial in the gestation, explosion and development of 15M. Technopolitics oscillates between the massive re-appropriation of the use of digital platforms and the collective invention of new uses and platforms. This has represented a drastic reduction of the cost of collective action, an increase in the impact of campaigns launched in digital networks, and a greater capacity for constructing the meaning of what happens in real time.

- 15M political culture on the Internet is characterized by the centrality of collective identities and anonymity. Collective political identities pose a challenge to the political party system as well as to mainstream media networks. These collective identities are connected to a new political space, which is nurtured by a critical mass defined by its networked collective intelligence.

- The technopolitical tactics of connected multitudes represent a new grammar of collective action and open new possibilities for political intervention to wide spectra of the population.

- Those practices construct a symbiotic potential between the street and the Net able to cross the information barriers posed by big mainstream media. That nurtures social autonomy.

- The importance of emotions for 15M activation, reflected in the high emotional charge of tweets, is key in the formation and explosion of the movement. Emotionality has also been fundamental for nurturing the energy of the network-system as well as for facilitating swarming and catalytic phenomena.

- The imbrication of emotions and technologies (that articulate with and provide feedback to them) has allowed the connection of the network-system as a whole. In the peak of its influence, 15M changed information and emotion consumption and production patterns. This generated intense common experiences and identities.

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- The relevance of strategic communication, mediated by mobile devices and oriented to generate empathy, has served to defend 15M from external aggression. With that it has shown that a collective body, when it is massive and highly connected, reacts to attacks by growing and expanding itself.

- 15M digital structure grew in a self-ordained and emerging fashion thanks to a technologically structured contagion in connection with augmented events. That structure grew exponentially and self-organizationally, as has also been shown by the study of the Institute of Biocomputation and Complex Systems of Zaragoza (Borge-Holthoefer et al, 2011)

- There have been different types of collective behavior in 15M: swarming and catalyzers. Swarming is defined by collective action, ephemeral in its formation and massive in its mobilization, which combines emotional affection with the activation of synchronization sequences. Catalyzers appear related to phenomena of self-organization at the meso-scale, with smaller groupings that play the role of inducing certain activity rhythms in the network-system as a whole.

- The network-system is activated by sequences of collective synchronization. The moments of peak intensity take place in the feedback between physical and virtual space, when languages and moods are tuned. In our time, multiplication of social stimuli and digital worlds has generated a huge process of social dispersion. For this reason, the thematic of the augmented event and multilayer synchronization is valuable in order to think the generation of new forms of political organization and collective action in the network society.

Among the advances in the conceptual and methodological terrain we can underline:

- The elaboration of an original conceptual framework, which we believe may serve as a base for a wider research program on 15M and similar phenomena (Occupy, YoSoy132, etc.).

- The development and application of new analytic methods and models based on complexity sciences, network analysis and data engineering. These methodologies allow an original approach to the study of movements in the network society. Thanks to them, our study has shown the need to think 15M as a phenomenon that goes beyond the traditional conception of social movements.

- The connection between materials (interviews, databases, images, etc.), experiences internal to the movement, and heterogeneous disciplinary knowledge (sociology, physics, biology, philosophy, data science, etc.) oriented to address 15M's complexity.

- The combination of qualitative and quantitative methods in order to craft a perspective that is, at the same time, internal and external to the phenomenon.

- The development and testing of real-time analysis techniques and tools (with still a wide margin for improvement). In our opinion, this will help to improve (and to understand how to improve) the systematic study of this type of phenomena and, what may be more relevant, collective action itself.

We also want to extract some political conclusions about what 15M has brought about:

- 15M closes the narrative on the crisis crafted by the binomial bipartisanship-mass media and points towards the emergence of a new social power: decentralized, transversal, autonomous and beyond the established categories of left and right. This points to a paradigm change, to the rejection of a form of democracy as non-interactive simulation.

- 15M has democratized the production of political narratives and meaning, it has opened a space to dispute the production of reality. It has generated information fluxes that deactivate the propaganda and hegemony of its "enemy". It has constructed a collective body-story that disputes reality, opening new possibilities of action and prefiguration of a world "other". 15M is a circuit of self-evaluation of our society and its problems, a common debate on social conditions, an autonomous diagnostic in the context of the crisis and austerity politics.

- For all of this, we risk to prognosticate that politics willing to change the current status quo will start, in the proximate future, from an awareness of the power of networks for constructing emotional and cognitive states as well as for intervening into the different layers of the social.

We believe it's important to point out some difficulties, problems or limitations that we had to face in the different stages of the study:

- Difficulties in the delimitation of the object, due, on the one hand, to its complexity and, on the other, to its condition as living and changing phenomenon.

- Limitations for gathering the desired data (beyond Twitter) in order to carry on the multilayer analysis, due to the restrictions imposed by technological platforms and the obligation to capture a posteriori data (many of which are not public). Especially relevant would be to have Facebook data samples, since it has been crucial for 15M, but we haven't analyzed it in detail in this study.

- The difficulties of integrating qualitative and quantitative methods and, especially, of combining them in order to enrich and deepen the analysis. This limitation is motivated, in part, by the limited research time we had for this work.

- The partiality of centering our attention on augmented events, the big 15M events. In this way we have somehow neglected aspects such as the day to day work of local processes and the specificity of the network subsystems, which deserve specific attention. This limitation has to do with the election of a systemic look that we wanted to give to our study.

- Not having worked through the layer of 15M contents and proposals, since we have focused on its structural, technological, emotional and organizational dimensions.

- Not having attended, with a critical perspective, to the problematic internal dynamics of the movement. This may result in an excessively positive view, which does not attend to the limitations of 15M. This being true, our approach to its potentialities is an epistemological and political choice.

- Not having dug into the emotional dimensions using a more qualitative approach.

- Not having analyzed the transformations in the environment and the macro-social reality of the country in connection to 15M.

10. Open research lines.

Our study tries to set the first stones in the construction of a series of new methodologies and of a research program for analyzing self-organized political behaviors mediated by technology. One of our objectives is to study technopolitical movements and revolutions in the network society. For this we are developing a model of analysis able to integrate data corresponding to network structures and topology, multilayer synchronization, emotions and languages, fractal and multifractal indexes in the activity of the system, and still new elements. We believe that the relation between these parameters will strengthen the present study and could be of interest for comparative studies on movements similar to 15M.

One of our next steps is focused on studying in depth the emotional dimensions in their most qualitative aspects. We will try to cast light on the relation between networked collective action and emotional activation. We will pay attention to the emotional traces left by 15M in the general population, and particularly, in activist networks.

We believe it is important to dig into each of the methodologies used in the study, in order to increase their precision and consistency level. At the same time, we hope to advance towards a greater integration of those tools. Our intention is to fine tune the combination between qualitative and quantitative techniques of study.

Thanks to the present text, as to the work of the @datanalysis15M group, we have identified several new lines of research. These are complementary to the ones developed so far, and we hope that they will turn into a research program able to expand the results of the present work.

Some of these new research lines are:

- Emotional epidemics in networks. Model of multilayer contagion of political emotions.

- Narratives and transmedia imaginary of 15M collective identities.

- Comparative studies: Arab Spring, Occupy, and Yosoy132.

- Development of meso-scale and community models in order to better understand 15M's network-consciousness.

Research coordinated by Javier Toret, with the direct participation of Miguel Aguilera, Pablo Aragón, Antonio Calleja, Alberto Lumbreras y Oscar Marín, all of them members of the group Datanalysis15M.

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The used datasets and dictionary of emotions are available here https://github.com/datanalysis15m

Entity and concept recognition software as well as emotional content analysis software is here https://github.com/OutliersCollective/languageTools, under MIT license [http://opensource.org/licenses/MIT] (Copyright 2013 Oscar Marín Miró, Alejandro González Díez y Rubén Abad Agulló)

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