The use of modularity algorithms as part of the conceptualization of the perspectival form in large networks

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ABSTRACT

How can we identify perspectives in large networks through the application of modularity algorithms? In the digital humanities [1][2], there is a fair number of scholarly work exploring computational routines to cluster and analyze enormous amounts of data. Recently, social data became a valuable source to study collective phenomenon, they provide the means to comprehend human collectivity by using graph network analysis. In this paper, we describe our approach on the manner of post-social anthropology [3] and social sciences using technical methods: quantitative analysis and modularity optimization. The computational turn is part of the ongoing process to conceptualize the "perspectival form", as the other would be the semantic analysis of the qualitative data. This technique uses a python script to extract the co-occurrence hashtags network from a Twitter dataset in order to apply in the context of the open-source software Gephi. Our experiments successfully exhibit how social networks can be unfolded when submitting a sample dataset of hashtags to the procedure found in the critical dimension of computational models. Therefore, it discovers the flow of perspectives when the strategy is follow in new workspaces, creating then categories that reveals points of view underneath the controversy. Concluding, this study presents a theoretical and methodological framework based in the post-structuralists, a composition that aims to support studies in different fields of social sciences and humanities.

Categories and Subject Descriptors

D.3.2 [**Programming Languages**]: Language Constructs and Features – *abstract data types, polymorphism, control structures.*
I.5.3 [**Pattern Recognition**]: Clustering - algorithms, similarity measures.
J.4 [**Computer Applications**] Social and Behavioral Sciences – Sociology

General Terms

Documentation, Human Factors, Theory, Algorithms and Design.

Keywords

Post-Social Anthropology, Network Science, Amerindian Perspective, Modularity Algorithms, Complex Networks.

1. INTRODUCTION

This paper understands that social networking is an anthropological phenomenon. A graph of social networking is a material representation of human relationships. Therefore, both the algorithm that seeks to analyze them, as the natural language vocalized on them, are in continuous process of interrelation to interpret the social world. The algorithm alone does not explain these relationships. But collective action, today generative of digital traces [4] cannot be explained alone, only with historical social theories of the humanities.

Graph clustering or community detection [5][6][7][8] in complex networks have a long history of research in machine learning and graph theory [9]. The studies in the field have gain attention from several areas, the most common studies are find in biology, technological, and physics. In the meantime, the literature in Natural Language Processing [10][11] and Probabilistic Neural Networks [12] have shown us the possibilities in document modeling, text classification, and collaborative filtering for large corpora.

In this paper, we describe a certain method developed by researchers at Laboratory of Studies in Images and Cyberculture (LABIC)[1], located at Federal University of Espirito Santo (UFES), Brazil. It consists in being a simple, but efficient and peculiar method developed to support studies in social sciences and humanities. Our novel perspectival framework uses a Twitter dataset publicly available online, thus, a variety of 500k+ tweet twitter feeds are draw on for examples. Such method uses Gephi [13] and its algorithms, resulting in visualizations and statistics. The method aims to find communities on a network formed by co-occurrence of hashtags in a tweet, in other words, we set a network of hashtags in order to compose a multiplicity.

The relevance in the contemporary context of online network sites serves as the means to interpret the political and collective actions, that is why Twitter is our "field" of work. We consider the social network a rich terrain of dispute, noticing the many uprisings around the world: #OccupyWallStreet, #15M, #OccupyGezy, #VemPraRua, and #NãoVaiTerCopa. Other social phenomena can be considered a perspective in progress, like #ClimateChange. While recently proposed methods practice detecting topics in historical and literature corpus by using probabilistic topic modeling [14], we aimed to present a new methodology to underline not just a topic model procedure for digital data, but to reveal the points of view in constant flow, in fact, profiles in a battlefield.

In order to comprehend the layers of texts in the digital traces left by humans, we rely in the actor-network-theory [15]. The main idea is to work in the same level of both, the actors and its

[1] http://www.labic.net

attributes. “A network is fully defined by its actors." [16] ANT and network analysis provide the argument to study digital data without worrying about the standpoint of the individual or collective. It is possible to negotiate to one level to another, from the parts to its whole, only by continuously rearranging the actors, or the nodes. There is no overlapping, it is matter of reorganizing ones positioning. The cartography of controversies [17] is the didactical application of the ANT, it serves as a range of techniques to explore public debates. Observation and description is essential to the scholarly work done in this paper. In this meeting between computing methods and the post-social anthropology [3], the Lautorian socio-technical networks approach will support the process of revealing points of view in disputes.

Our methodological framework poaches the Amerindian Perspectivism [18] to find the foundation for our ongoing experiments to compose a "perspectival form" in large networks. Again, they are called large networks because they are made of thousands or even millions of nodes and edges. Most importantly, comprehending the node as a social profile in the network, thus, the edges, as the link between One and the Others. Then, a network is only constituted by the existence of the other. Eduardo Viveiros de Castro subverts the idea we have of cannibalism, which is an idea that guided in the conception of "to cannibalize" the other is to eat the other. He inverts the enunciation, saying that cannibalism is a way out of self to go into the other, for each other. The node as a profile on the social network it increasingly comes out of the self to "retweet" what is better or worse from another, therefore, assuming the point of view of that other (and they are of many types). Nowadays, the other is the element that captures us. It is an anthropological turn, which we live in.

In fact, this is our inspiration to reconceive a qualitative-quantitative method of analyses throughout machine steps, which we know in computing as the algorithm. When applying these procedures to comprehend collective phenomena, it produces new perspectives and methods. The computer requires the cascade of texts and hashtags we collected in our dataset to metamorphose into the grid of numbers. [19] The framework we have been testing is based in the Louvain algorithm [20], in which we compute to maximize the network modularity.

The use of Twitter, in particular, has led us to a couple of challenges in text clusterization process. As the qualitative research process evolve and the number of tweets increases to millions, categorization and the topology of the network became a problem. “The whole is always smaller than its parts”.[16] A large network features an illusory representation. It overlaps itself in distinct layers, social groups and thoughts, as if was part of a single network topology. In theory, the social is crossed by a multiplicity of natures, perspectives, worldviews, produced by different human groups. And here is our hypothesis: thereby, every network is, rather, a network of perspectives, which are usually in dispute.

The methodology that first was based in data mining and clustering thousands of words needed a new framework. Given this problem, we created the hashtag network script. After the consultation of literature available [21] new possibilities have rise, from the initial goal to find a method to fastening clusterization of words and categories to the use of hashtags to find perspectival forms. Nowadays, the discussions indexed to a hashtag often become themes of conversations between halls. The hashtag, based in our tests, prove to be the better solution for social scientists working with data science. When using the hashtag sign, the user is segmenting a topic of interest, more than that: he allies itself to a point of view on a subject. It is simple to analyze that once someone have generated a tweet and already used a hashtag, it is as if the user is already categorizing the text for the researcher. In addition, the hashtag represents the existence of a debate that matter or even just some cause that people aimed to call attention for it. Either way, the many ways that people give meaning to points of view by indexing value to a specific word will qualified a perspective in the public debate.

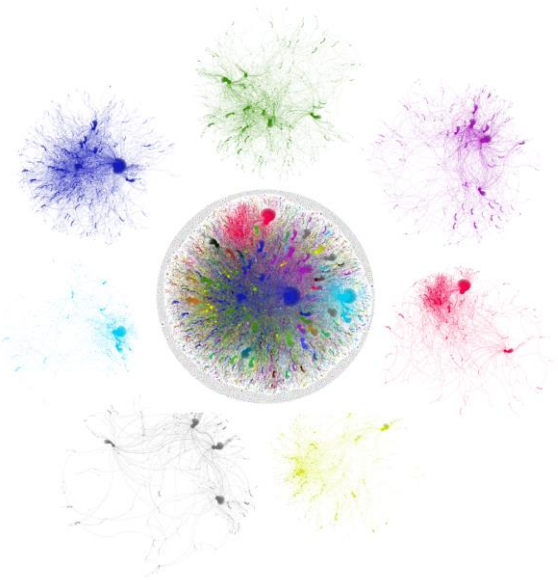

Figure 1: The figure shows the center of the network #VemPraRua, consisting of 125 000 Retweets. Only when analyzing the perspectives (networks around the center) it is possible to understand the different perspectives on the network.

2. THE ANTHROPOLOGICAL THOUGHT AND NETSCIENCE

The substance of our framework is in how we interpret modules without changing the levels or scale of plan. In online social networks, we argue the existence of movements and circulation in a flat surface with no consideration to hierarchy. The node is situated in the terrain of dispute, one that is only defined by its network.[16] In this case, when exploring the dots in the graph, which in our dataset are the hashtags, the actor moves to the network, interacting with others in the same level. This is where we stand with Latour, in a flat ontology.

The approach we reclaim to study online networks is the one inherit from Pierre Clastres.[3] In any case, we propose a descriptive study of a terrain which we understand to be in constant dispute. This allows us to rely once again in the indigenous world, which there is a surviving violence itself, a reference to problematize the thesis of repulsion and attraction of the algorithm of modularity. In short, we make use of the concept of cannibalism, which derives from the complex notion of cannibalism. Applied in the field of hashtags as views, this very cannibalism lives of the perspectival forms within the network

revealing then a mode of operationalization. This is a process of maximal reduction of one single node and another, almost like a microscopic work to see the minor points of view. "Exchange, or, the circulation of perspectives: exchange of exchange, that is, change." [22]

In data science, complex networks [23] are identified as very large networks, millions or billions of nodes and edges. This sort of networks occur in different contexts, it is possible to recognize in nature, society, technology, economics, etc. One of its fundamental characteristics is the temporal evolution aspect. Complex systems constitute themselves of many non-identical elements connected by a diversity of interactions. Several networks in nature, ecology, economics, human relationships in social networks and the web has the same topological structure. They are known scale-free networks [24]. We will associate this computational concept with the understanding of networks from Bruno Latour.

In this sense, the actor-network theory (ANT) comes in hand with the inquiry we propose. The large networks in this empirical study come from the NET, which we purposely stress in the same way Latour does with ANT. To trace the circulation and interactions of points of view and objects, ANT is going to explore the constitutive connections between actors (the actants), both animate and inanimate, and the generative potential of those interactions. In his own words, "(…) network does not designate a thing out there that would have roughly the shape of interconnected points, much like a telephone, a freeway, or a sewage 'network'… It qualifies its objectivity, that is, the ability of each actor to make other actors engage in unexpected relations."[15] More precisely, we consider social profiles as living things. Often happens that in the information networks, it is not possible to recognize the "form", only the information. By that we meant the profiles that uses the language like a human component, but notice, they are only information, or robots to act as man. However, the meaning arises from the disparate actions. [27]

We mend our theoretical foundations in the connections we perceive between anthropology and post-structuralism. Which summing up is circumscribed in the post-social-anthropological net of authors listed here, considering then the deleuzian concept that comes from the mathematics, where we find the means to comprehend the multiplicity as a point of view. It creates a new kind of entity, rejecting any generalizations, the one we know as 'rhizome'. Therefore, a rhizomatic multiplicity does not, in fact, behave as one, because it is not possible to do that when it operates as assemblages of becomings. Here is when Latour meets Deleuze and the notion of actor-network, one which the network cannot be one thing, yet, again, because anything can be considered a network.[22] And finally, in the next section, building up from this interdisciplinary dialogue, we present how the amerindian perspectivism support our hypothesis in exploring the complex world of large networks, finding a perspectival form within the modularity algorithm.

3. THE PERSPECTIVAL FORM WITHIN THE MODULARITY

We were called into the indigenous world to reflect the network studies, mainly due to a natural notion of multiplicity in the indigenous society.[26] Primarily because we have for long studied in information networks, a political aspect that we find in the modes of existence peculiar to the indigenous society, a way of existence, i.e., a substantially minor of existence, in a minority character. Therefore, we are concern with the mechanisms that inhibit or block the emergence of a totalizing discourse. Therefore, "perspectivism does not state the existence of a multiplicity of points of view, but the existence of the point of view as a multiplicity." [27]

Modularity is one of the possible measure for detecting communities in complex networks. A set of nodes categorize itself as community by its modularity if the fraction of links between them is higher that expected ia network called "null model", which is used as a reference. [28]. A complex network with a high modularity indicates strong community structure, in other words, the nodes inside the same community has a dense connectedness and has a sparse connexion between other communities.

The algorithm applied in this paper to find communities, since we use Gephi [13], is the Louvain Method. Such method does community detection in weighted graphs and has characteristics such as greedy heuristic, local optimization of modularity, very fast (complexity O(nlog(n), n: number of nodes), non-deterministic, return hierarchical partition. The Louvain Method is an "algorithm that finds high modularity partitions of large networks in short time and that unfolds a complete hierarchical community structure for the network, thereby giving access to different resolutions of community detection." [20]. Think of the network as a perspective. Well then, the nodes that compose such network will form an alliance, ie, they will form a covenant relationship between viewpoints. The link between two nodes is exactly the distance between them, and also, the distance between points of view. It turns out, then, that the way which we apply the algorithm maximizing the modularity, the network is partitioned into modules, testing all nodes until no node can belong to another module. It is a dimension of alterity, the same as found in Amerindian perspectivism. "Perspectives encourage you to believe OUT of them." (Roy Wagner)[2] The algorithm repeats this process of exchange and change, successive times for all nodes. Autophagy is a survival of hashtags in the network. A roundup of alliances.

4. METHODOLOGY

"The object as such: why a perspective is not a representation"[31].

The first step of the method is, of course, to have the dataset to be analyzed, the collection of tweets formated in a comma separated file (csv). The tool utilized to get these tweets is called yourTwapperKeeper[2]. The procedure begins with the choice of a term or hashtag, the tool does the job of archiving the massive amounts data. This process provides a historiography of what have been vocalized related to the research expression. With enough data to go through ethnographic rendering, we can go to the "field", which for us means to explore a database of entities and attributes.

The second step is data processing. As we know, hashtags are one of the most commonly used form of categorization and indexation among users in social networks, such as Twitter and Facebook.

[2] http://www.github.com/540co/yourtwapperkeeper

One can say that the hashtag summarize the content of the tweet, positively or negatively, confirming it or contradicting it. So, this next step consists in creating a "Hashtag network" from the tweets previously collected. The Hashtag network is a complex network that links hashtags if there is co-occurrence between them in the same tweet and it forms a weighted network, as it can happen twice with the same hashtags. The creation of this complex network is provided by a script programmed in our lab and its output is a csv file that will be used in the data mining process.

The third step relies on drawing the network and manipulating with its structure. In order to visualize the network, we import it to Gephi. For now, the first view of the network is a hairball, a completely unintelligible graph. This is the time when modularity comes into the picture. But before that, there's a very important act. We will have to delete the "main node", in other words, the hashtag that links all nodes. Therefore, the next move is to apply "Modularity", set the parameters of your choice and wait until calculation is over. Next step, applying the modularity class calculated for each node and thus forming the communities. One way to apply it on the network is setting the colours to the nodes, thereby emphasizing the communities, in our case, the topics of discussion. The next important move is to calculate the "Average Weighted Degree" which gives the user a way to apply different sizes to the nodes from their weighted degree, and this was the next step. The network isn't longer a hairball and the recognition of communities is clearer, thus, as for the biggest nodes in each community, they define the points of view of that community.

Lastly, each community is a network of point of views and they are distributed through Gephi's workspaces. Now, we apply the modularity and calculate the average weighted degree again. The final touch consists in setting the design of the graph with the "Circular Layout" option, it is also more visually interesting to order the nodes based in the modularity class. We advise for matter of design to find the node with higher degree, in which we will identify the most prominent point of view of the particular network. By now, we expect for terms of visualization and exploration to have a network of hashtags, i.e, the perspectival form of the network.

4.1 The case with the #WorldCup

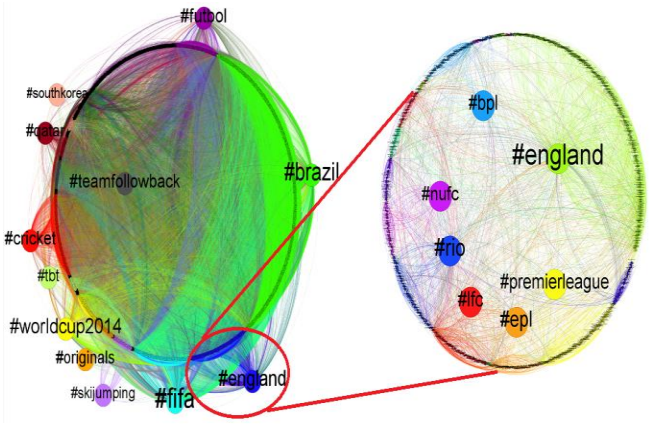

Figure 2: #worldcup's main perspectives and #england perspectives on #worldcup.

The dataset consists in 271.013 tweets that were collected between february 4th and may 4th, 2014. This image is a view between acts in the third step of our method, after the first pass of the modularity optimization algorithm and rearrangement of the nodes with highest weighted degrees in each perspective. It is an overview of #worldcup's hashtags network as the main perspectives are emphasized. As we can see a certain noise or distortion is identified in the network, as in "#cricket", where the hashtags mean to mention the cricket world cup, or in #teamfollowback, where users tend to flood their timeline in order to get more followers.

In this perspective of the network (Figure 2), it is visible the english topic being discussed. The different subtopics, evident among the nodes, make this assumption clear. And so, as seen in the hashtags #epl, #bpl and #premierleague, meaning the discussion of the English Premier League a.k.a. the english national championship, and in #nufc and #lfc, meaning Newcastle, United FC and Liverpool FC, both english teams, and last, but obviously not least, the hashtag #rio, that clearly connects the main discussion #worldcup, as the English team is going to train in the Rio De Janeiro city before the cup.

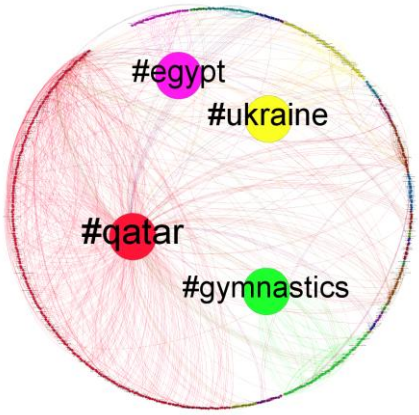

Figure 3: #qatar perspectives on #worldcup.

After emphasizing the nodes with highest weighted degrees, the human interaction, as research, is truly required to engage the process of perspective perception. The hashtag #ukraine involves the perspective of protests and their recent history with russia, the multiples hashtags are seen in the composition of point of views.

We can identified the following words: #crimea, #sanctions, #russiainvadesukraine, and #worldwar3. But also in this perspective, there is fractal element, because we can also foresee the hashtags #wc2018, #2018worldcup, and #worldcup2018, which suggests that people are already expressing concerns on the country that will host the next world cup, in 2018. As for #gymnastics, the perspective lies in the gymnastics world cup that happened in doha in 2014, which can be seen as noise in our main investigation. And in #qatar, where the 2022's world cup will be hosted, the multiplicity, as point of view, is focusing on several discussions involving #humanrights, #workersrights, #slavery, and such.

4.2 The case with the #ClimateChange

The dataset on climate change was collected between February, 2nd and May, 5th of 2014. In total, we have exactly 1.048.576

million tweets. To analyze the data, we put together a hashtag network of 21.415 nodes.

The number for the hashtags provides a sample of the "heat" of the debate online. In the Figure 4, we had only computed the modularity the first time, the graph display the partition of the network into modules. The points of view with higher average weighted degree indicates as results: #carbonbubble, #energy, #obama, #tcot, #nsa, #gree#, #news, #ows, #truth, #obama, #bbcnews, #fracking, #travel, #jobs, #earthday, #organic, #climate and #climate2014. Who is what in this network? Appearances can be deceptive, although, a few interesting revelations appears already. For instance, #tcot means Top Conservatives on Twitter, this network has a longer effect in the network because it has has an alliance to american Tea Party.

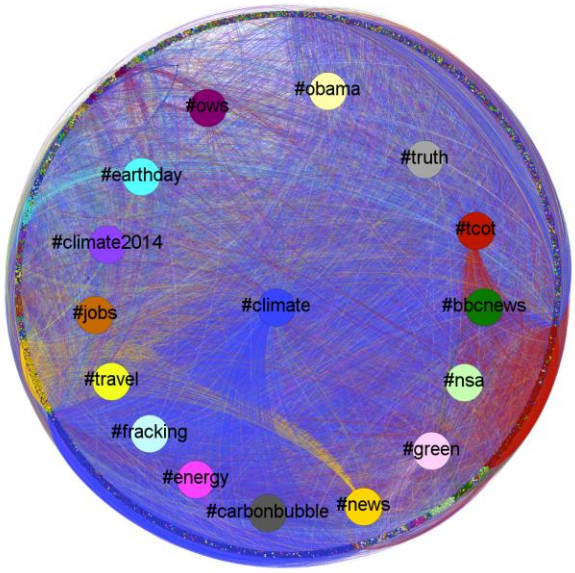

Figure 4: #climatechange perspectives.

Still, note that we have design the perspectival forms in order to visually demonstrate the capacity of some point of views to establish more regimes of alliances. In this orange network of point of views, the high value of internal modularity, clearly echoing the american Republican Party tongue. At the same time, the green network maintain a link to the orange network, the multiple points of view embedded in this green network are #globalwarming and #deniers. No wonder, this perspectival form preserve this alliance with American conservative party.

The blue network proposes a perspectival form of the anthropocene. A hahstag itself, #anthropocene reflects the currently reality of concerns brought by the notion of Gaia. Bringing issues like # energy, # food, # weather, a dimension of the ecological crisis. The reflection of man before the outburst of Gaia. In this case, the blue network has links to the different perspectival forms, such as the #cdnpoli, a network of the point of views involving the environmental crises in Canada. In there, we can find the #KXL #KeystoneXL, the hashtags used about the oil debate.

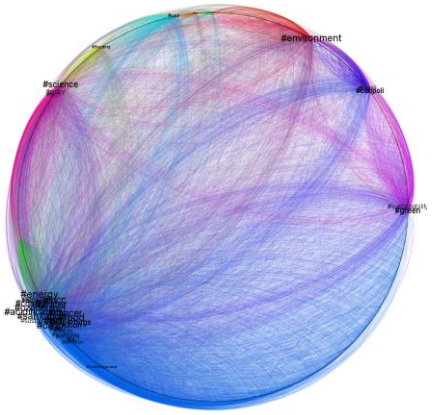

Figure 5: The blue network arises as a perspectival form with high modularity.

5. CONCLUSION

In this paper we have presented theoretical references in Post-Social Anthropology and Complex Networks to support our methodological framework for studies of social information data. Twitter is a rich field of productions, it can create alarming discussions over the necessity to debate the ecological crises, such as the hashtag #climatechange. There is a social memory within the hashtag, that's why in this research we addressed the exploration of points of view though the hashtags in the network. However, the hashtag is also a fictional character that brings together a collective memory and puts it to act in the public space, influencing the understanding of what we understand to be reality. This is not a simulacro 2.0, it is a practice that activates a mode of human existence, the fictional, to expand our critical capacity.

In the case of #climatechange, we confirmed the existence of a variety of networks in the large network. Different perspectives that are completely distinguishable. Such as, the distance between #actonclimate and #teaparty.The analysis of the #worldcup assemble the perspectival form as a multiplicity. Inviting us to dig into the point of view, emphasizing that it is not possible to generalize the network. This procedure, that analyzes the co-occurrence of hashtags in a dataset of tweets, leaves behind tweets with no hashtags and one hashtag only. This implicates on a certain limitation for the method, but also it focuses on its main goal: to study the connection between the hashtags of a tweet and perceive the perspectival form originated by its connections on a complex network.

We describe the intercorrelation of algorithms and the humanities, together it composing a powerful tool that allows a routine of data mining, processing, and visualization of social information. Applying our research methodology has evidenced our hypothesis since it indicates that there are variety of points of view, so a more detailed study of network demands to take into account the perspectives of the network. It is also important to note, perspectives converge in the same direction, so the groups are well defined in which side it defends. Our method indicates that research involving informational networks, such as studies concerning degree, sentiment, hub and authority, which do not take into account the perspectives in dispute in the networks, will tend always to reach conclusions that privilege the richest nodes with more connections. For future work, we plan to refine our

methodological frame with tests in other datasets and to improve the visualization of the perspectival form of the network.

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