



NoVax Speech on Twitter about Covid-19 Vaccination in Italy

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Abstract

This study takes a closer look at the public discussion that emerged in the online world in response to the Covid-19 pandemic. By analyzing Twitter debates from the period of March 2020 to May 2022, the authors aim to comprehend how the public discourse evolved throughout the most critical phases of the pandemic. To achieve this goal, the authors use a combination of Network Science and text analysis tools. The Network Science approach involves constructing a graph representation of the tweets, where hashtags serve as nodes, to uncover the relationships between them. In addition, the authors employ LIWC software to perform a semantic analysis of the tweets, which enables them to examine the underlying meanings and sentiments expressed in the discourse. The study provides a comprehensive examination of the online discussion by combining both technical and semantic analyses. The findings from the network analysis provide a bird's eye view of the structure of the conversation, while the semantic analysis delves deeper into the content of the tweets. This combination of approaches provides a robust and thorough understanding of the public debate during the Covid-19 pandemic.

1. Introduction

1.1. The Vaccine Against Pandemic

On 11 March 2020, the WHO (World Health Organization), after assessing the severity levels and global spread of SARS-CoV-2 infection, declared that the outbreak of COVID-19 can be considered a pandemic. In a short time, Covid 19 shook the lives of all people across the globe, as well as bringing multiple damages to the sanitary system and economy of countries. From this moment on, people had to forget their habits and lifestyles to make place for new ones. People were thrown into a daily routine of social distancing, home isolation, contraction of sociability and suspension of work, school and recreational activities. It is inevitable that such a great upheaval has led people to develop conflicting thoughts, due to fear, negative emotions, indifference and a lack of medical and scientific information.

1.2. The Social Media Platform

These days, social media platforms are indispensable for staying in touch with the whole world. People can express themselves freely, as social media platforms are easily accessible by anyone

with an Internet connection. At the moment, the number of people with an active social profile is around 4.62 billion. With the outbreak of the pandemic caused by COVID-19, social media has been the outlet for users. The speed with which statuses, photos and comments spread means that users can see in real time what is being written. This often leads to disagreement. Social media are used as a stage for political speeches and debates, where users through likes, retweets or comments can express their agreement or opposing views. During the pandemic, the lockdowns and the rapid creation of a vaccine, users more than ever have expressed their opinion on social platforms. Mass media and social media published news about COVID-19 day after day. Users, especially the more skeptical ones, took the opportunity to post complaints on the topic, often using aggressive words and hashtags. What is written has a major influence, especially for those who are 'weak users' of the web. Specifically: "Vaccine hesitancy continues to limit global efforts in combatting the COVID-19 pandemic. Emerging research demonstrates the role of social media in disseminating information and potentially influencing people's attitudes towards public health campaigns." (Fidelia Cascini, (2022), Social Media and Attitudes towards a COVID-19 Vaccination: A Systematic Review of the Literature")

1.3. NoVax Community

During the Covid19 pandemic, social media users abounded to share their experiences, fears, and thoughts about it. Since the beginning of the pandemic, anti-Covid movements have started to emerge, more specifically, we refer to negationists and conspiracy theorists. This is a first step in order to understand the social divide that covid 19 has caused. People were confused by the multitude of reports, both true and false, that were being spread on social media. Later, when the vaccination campaign started, many users were against the vaccine to defeat covid, and they did not hesitate to spread their opinions and tried to increase the number of no vax in every conceivable way. To do so, these groups use various methods, including bots and trolls that generate anti-vaccination messages and spread rapidly. To go more specific, "the arguments that they use focus on possible harmful effects and the distrust of pharmaceuticals, promoting the use of social networks as a resource for finding health-related information. The anti-vaccine groups are able to use social networks and their resources to increase their number and do so through controversial arguments, such as the economic benefit of pharmaceuticals or personal stories of children to move the population without using reliable or evidence-based content". (Elvira Ortiz-Sánchez (2020), "Analysis of the Anti-Vaccine Movement in Social Networks: A Systematic Review.")

2. Research Question

The main objective of this research is therefore to analyse and understand "How has Covid vaccination influenced the novax community on Twitter". More precisely, our intentions are to understand what the speech of the no vax communities in Italy was like during the pandemic: what were the main topics and debates and the main feelings? At what stage of the pandemic were they most intense? With our research we try to answer these questions and highlight some aspects of an event which is as historical as it is actual, and which involves the entire world population. In order to answer these questions, two different research groups worked on this project to combine knowledge from different research areas to produce new results that will be useful for some future studies.

3. Data

3.1. Network division

The objective of this study was to analyse the changing public perception regarding the pandemic and vaccination campaign through the examination of data obtained from the Twitter API. The study utilized a consistent query across five significant time frames, with the first period covering March to September 2020 and referred to as the pre-vaccination campaign period. This period was characterized by the implementation of lockdown measures and a widespread perception that vaccination was still distant. The second period, from January to May 2021, was designated as the

vaccination campaign period, during which prominent individuals such as actors, singers, politicians, and influencers advocated for the benefits of vaccination. The final period, referred to as the Green Pass period, was divided into three sub-periods: October 2021, November to December 2021, and February to May 2022. This period was marked by protests and mobilization by a portion of the Italian population against the restrictions imposed by the government through the Green Pass. The tweets analysed for the study were retrieved using a query that incorporated the hashtags #nogreenpassobbligatorio, #NoVaccinoObbligatorio, #DittaturaSanitaria, #novaccinoCOVID, #nocavie, #primule, and #ProVaccino. During the report we will call the network with the following names:

- i March 2020-September 2020: Pre-Vax
- ii January 2021 - May 2021: Vaxcamp
- iii October 2021: October
- iv November 2021 - December 2021: Nov/Dec
- v February 2022 - May 2022: 2022

3.2. Network building

In order to analyse data, we built different graphs, divided as we described in 3.1. The nodes in our graphs represent hashtags and two nodes are connected if they are in the same tweet. Edges are weighted and the weight corresponds to the number of times two hashtags appear in the same tweet. So the graphs could be seen as a projection of a bipartite graph, where the first set of nodes are tweets, the second hashtags and the projection is on the hashtag nodes.

To have a more reliable analysis we discard some nodes in the network. First of all we discarded the hashtags that were queried, because, when we were building the network, we noticed that they were highly connected with the rest of the graph's nodes. There were also other highly connected nodes, which referred to hashtags not directly queried, but with the same letter as those queried with different lower/upper case. So we decided to discard them. After this building phase, the resulting graphs were disconnected. The majority of the nodes were part of a single "giant" component and the others (usually no more than 30 nodes) were made of other small connected components (about 10 of these, with a cardinality of 2/3 nodes). These nodes had extremely low weights, so they were discarded. Since, in fact, there is a connection between the topology of our graph and the semantic meaning of the hashtags, these small connected components were made of nodes (hashtags) not related to our topic.

In order to perform the analysis we used *Python*, a high-level programming language, and several libraries:

- NumPy to handle with numerical arrays
- Pandas to handle with Dataframe
- NetworkX and igraph to handle with the networks
- Matplotlib to plot our results.

In order to have a graphical representation of our network Gephi has been used, an open-source network analysis and visualization software package.

4. Semantic analysis methods

4.1. What LIWC is.

The core logic of Linguistic Inquiry and Word Count (LIWC) derives from decades of research showing that people's language can provide insights into their psychological states, including emotions, thinking states and social concerns. Sometimes, these insights are quite obvious and simple. Other insights, however, require a more in-depth study of their true meaning. LIWC is a psycholinguistic dictionary that assembles words according to a specific emotion to which they are related. This dictionary was primarily meant to attribute values to the entire text corpora. However, we used it with the aim of understanding the way communities expressed themselves to each other, certain subject-related topics, negative emotions and social concerns. We have chosen not to use all the dictionaries, but only the most relevant and appropriate for our research.

4.2. LIWC's dictionary

As previously discussed, in order to analyse texts, i.e. our tweets, we decided to look for the most relevant insights with respect to our topic that appeared in different communities and then compare them, subsequently examining why these insights were used.

The insights examined through LIWC are:

- Question Mark: the percentage of question marks in texts;
- Motion: the percentage of words related to movement in texts;
- Focus Present: the percentage of verbs in present tense;
- Verb: the percentage of verbs in texts;
- Social: the percentage of social concerns or social support perceived through the whole text;
- Health: the percentage of health mentions in texts;
- Negemo: the percentage of negative emotions perceived through texts;
- I (pronouns): the percentage of first person singular usage in texts;

4.3. Text Cleaning

In order to carry out a good analysis, it is first necessary to clean the text. From the tweets, we were able to conduct the following text cleaning prior to using LIWC for network analysis.

Python was used to filter the text in accordance with the following ordered steps:

- removal of links;
- removal of mention symbol (@);
- removal of the hashtag symbol (#);
- removal of the *RT* acronym;
- removal of the traits _ and - ;
- use of the hashtag words (without #) and put them in lower case with spacing;
- the emoji have been coded in Italian.

The emoji encoding procedure was performed using Demoji, a free open-source library for natural language processing in Python. After the text-cleaning phase, each content (tweet) in the database was uploaded to LIWC in order to analyse the text to understand the psychological meaning of the words.

5. Technical analysis

5.1. Average Path Length

The Diameter D of a network refers to the length of the longest among all the shortest paths between any two nodes. The shortest path (which we usually refer to as *distance*) is the minimum number of links between any two nodes. Consequently the diameter is a measure of the maximum distance in a graph and it is a convenient measure to characterize the size or spread of the network. For example, if the nodes "A-B-C-D" are connected, going from node A to D, the related diameter will be 3 (3-hops, 3-links).

5.2. Average Path Length Analysis

In Fig. 1 *et seq.* the distance distributions are displayed: on the x-axis there are all the possible distances between two nodes measured in a specific network and the y-axis shows the correspondent frequencies in logarithmic scale.

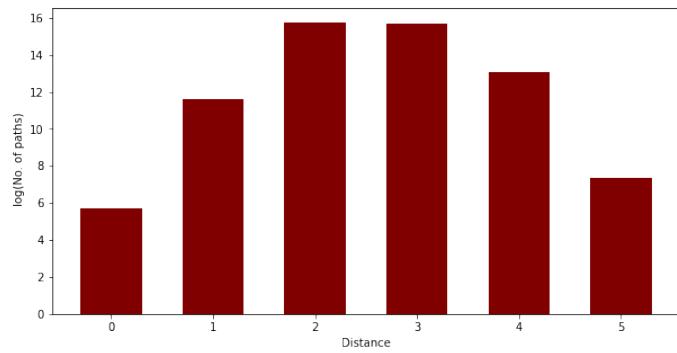


Figure 1. Average Path Length Pre-Vax

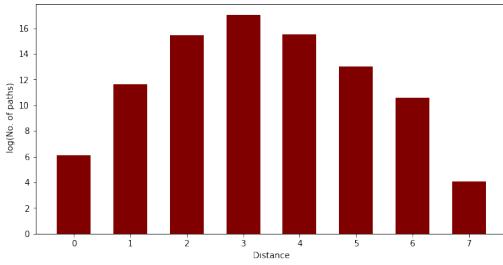


Figure 2. Vaxcamp net

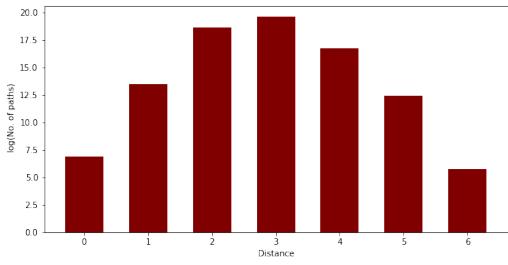


Figure 3. October net

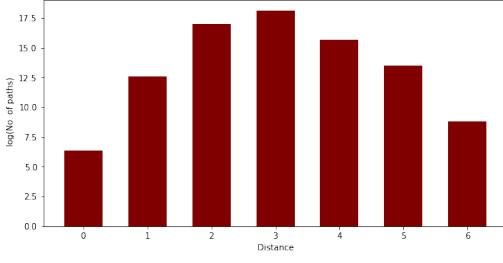


Figure 4. Nov/Dec net

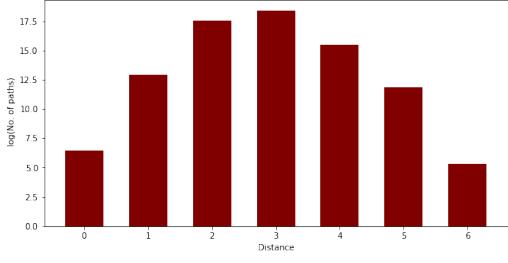


Figure 5. 2022 net

The trends seem to be quite similar with an average path length between 2 and 3. To better investigate the differences we refer to Table 1. The October network is the biggest one even if it is not the one with the highest diameter and average path length, which means that it is more interconnected than the others. On the other side, network 1 and 5 are the smallest and this is reflected by diameter and path length.

Table 1. Diameter and path length for each period.

Network	Diameter	Average Path
Pre-Vax	5	2.53
Vax-camp	7	2.90
October	6	2.74
Nov/Dec	6	2.85
2022	5	2.58

5.3. Frequency

Frequency refers to the number of times a particular hashtag is used in tweets over a specified period of time. It represents the popularity of the hashtag among Twitter users and can be used to measure the impact of a social media campaign or a trending topic.

5.3.1. Frequency Analysis

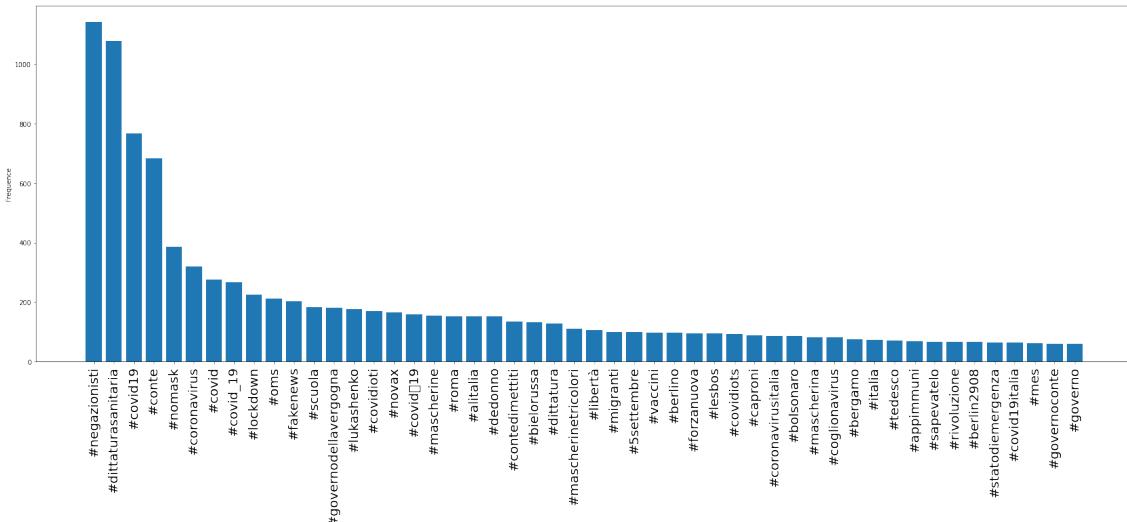
Frequency analysis enables us to determine the prevalent hashtags used by anti-vaccine communities and subsequently, identify the current trending discussions within a specific time frame.

"Denials" emerged as a trend in January among Twitter users who rejected the existence of the pandemic and vaccines. By the time, WHO declared that half of the posts in social media about the vaccines were "Fake news", which may have contributed to the anti-vaccine sentiment.

In March 2020, a "DPCM" (Decree of the President of the Council of Ministers) was legislated to control the Covid situation by the time. By the law, the country was divided in multiple zones. The "Red Zone" was the zone with the highest rate of limitations imposed by the government. Anti-vaccine supporters perceived this as a "Health Dictatorship".

In the following period, the "#novax" community, led by "#puzzler", held a protest in "#trieste" against the government's Covid policies, demanding the abolition of the "Green Pass" and respect for "#freedom". The prominent Italian professor Massimo "#cacciari" also contributed to the novax discussion from November to December through his appearances on television programs such as "Agora Weekend" and "Stasera Italia". He believed restrictions on Green Pass were intolerable.

In February 2022, journalist Daniele "#capezzzone" was invited to a talk show called "Quarta Repubblica" and criticized the Green Pass system after testing positive for Covid, despite receiving three vaccine doses. His views were met with enthusiasm by the anti-vax community.

**Figure 6.** Frequency of the hashtag in the tweets of the period March 2020-September 2020

5.3 Frequency

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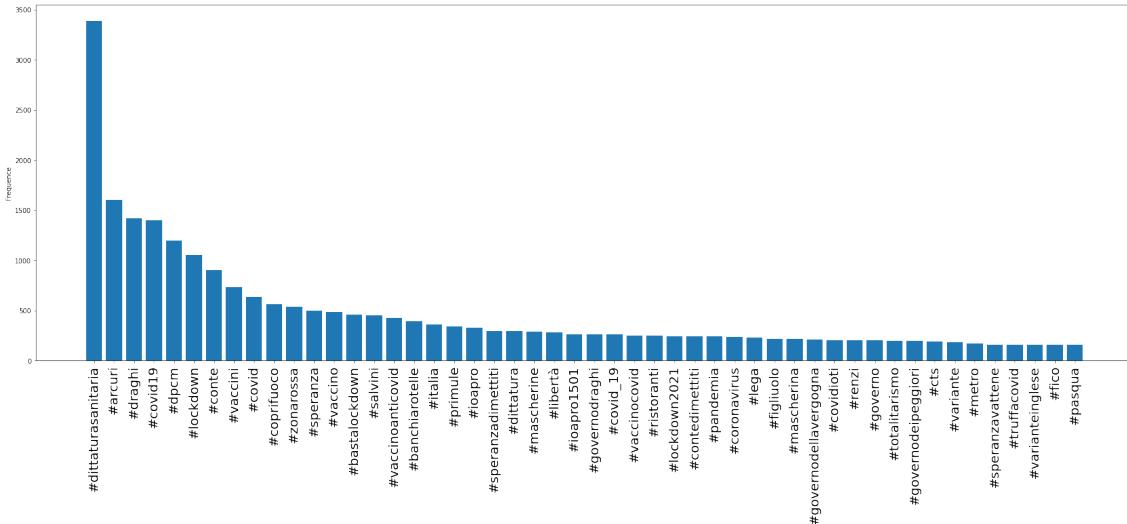


Figure 7. Frequency of the hashtag in the tweets of the period January 2021 - May 2021

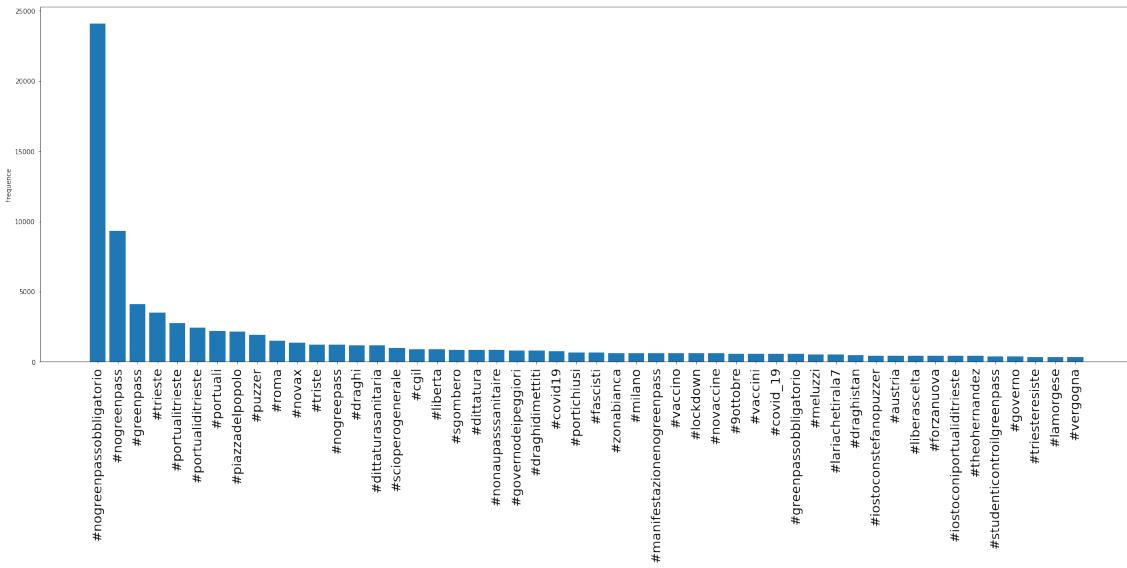


Figure 8. Frequency of the hashtag in the tweets of the period October 2021

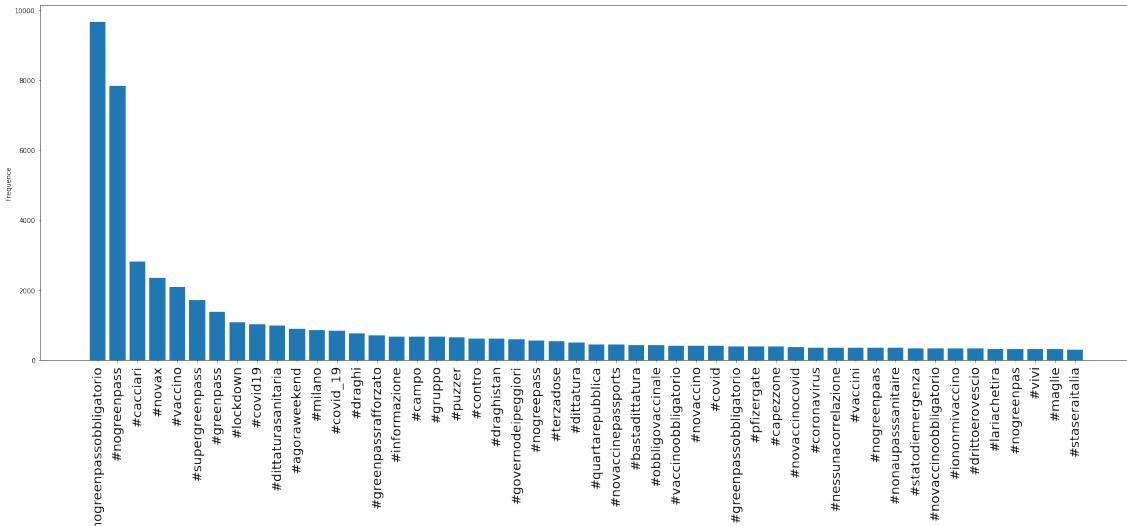


Figure 9. Frequency of the hashtag in the tweets of the period November 2021 - December 2021

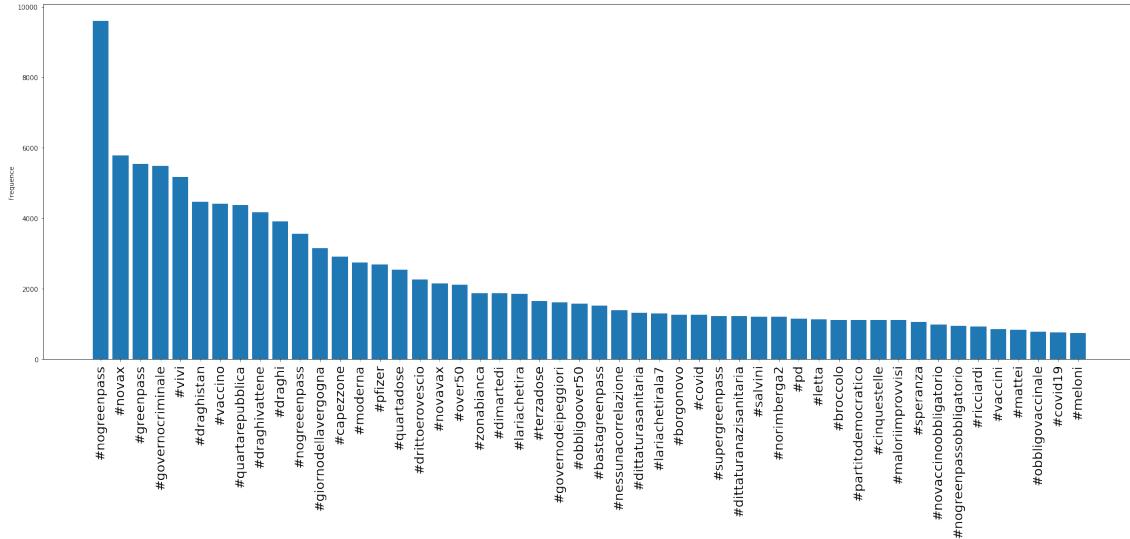


Figure 10. Frequency of the hashtag in the tweets of the period February 2022 - May 2022

5.4. Node degree

The degree of a node is the number of edges connected to the node. In terms of the adjacency matrix A, the degree for a node indexed by i in an undirected network is :

$$k_i = \sum_j a_{ij}$$

where the sum is over all nodes in the network.

5.4.1. Node degree analysis

In this section, we are going to analyze the extracted hashtags from Twitter in each period of time, to better understand the problems during the Covid-19 pandemic and the discussion among anti-vaccine people.

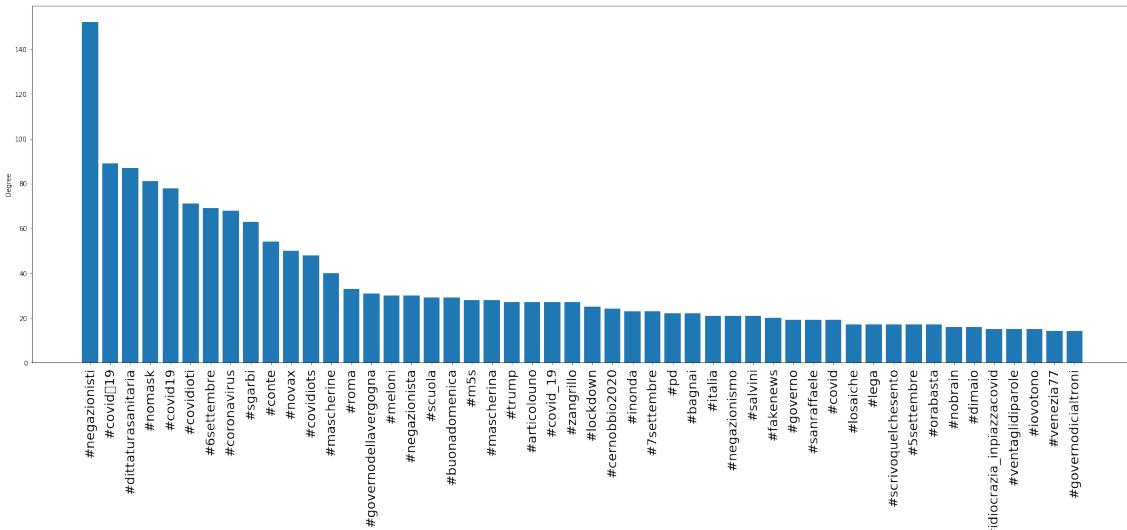
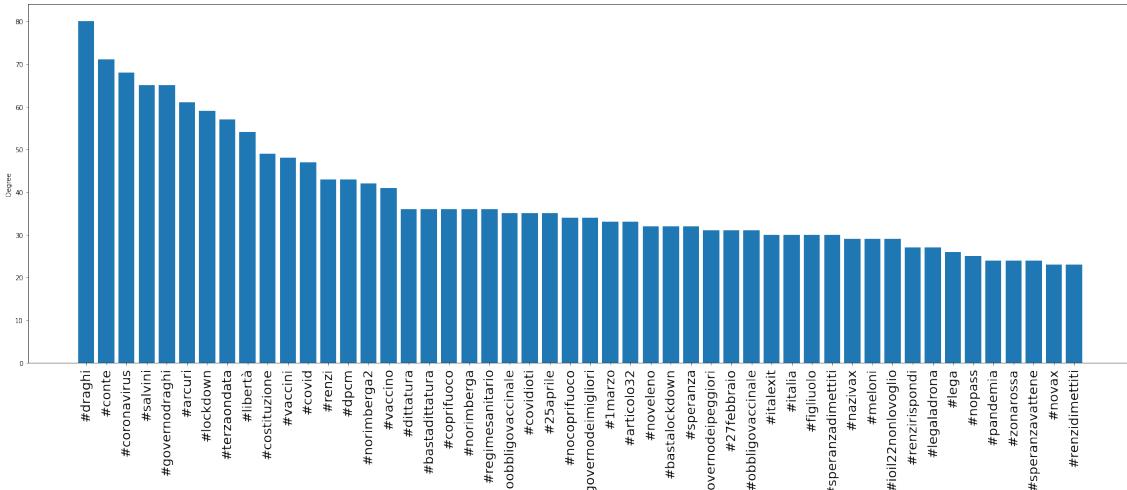
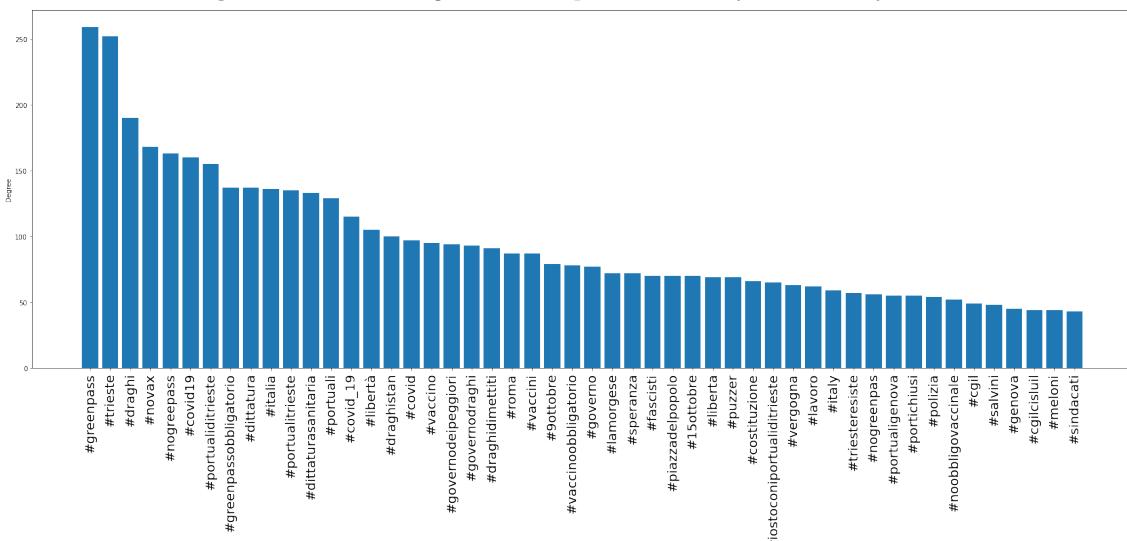
Denials were at the top of the discussions in the initial phase. The term "Denialism" indicates those who did not believe in Covid and the global epidemic, those who thought that the virus was all a fabrication invented by those who had interests in doing so, virologists and pharmaceutical industries. "#No mask" is a consequence of this debate.

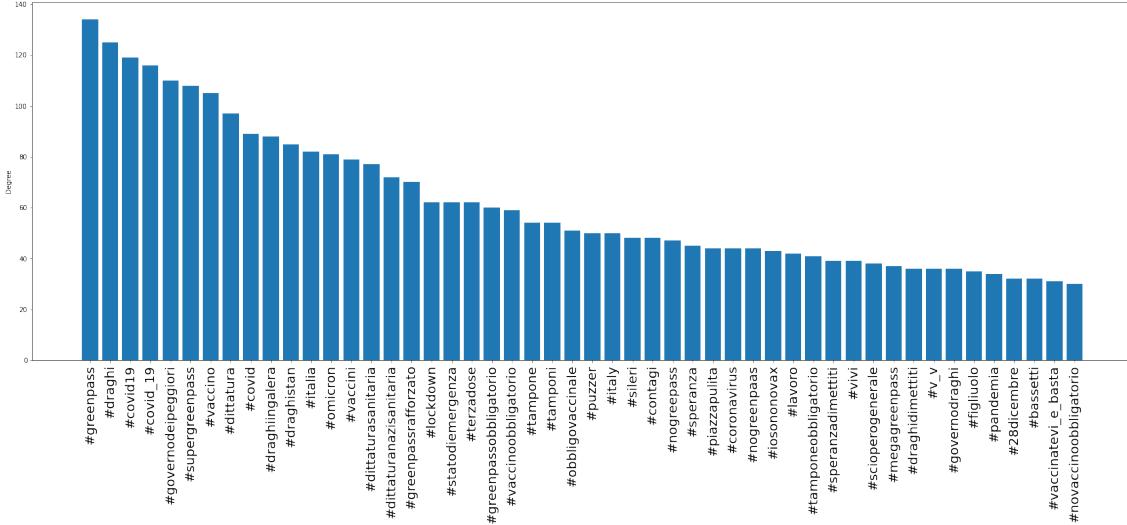
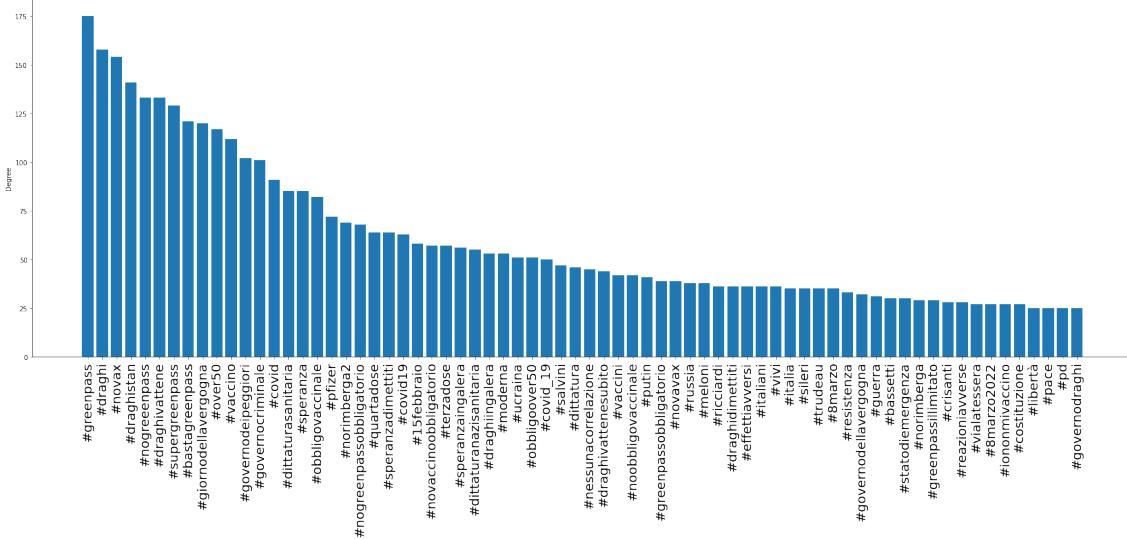
In the second period, "#arcuri" has a high degree. Domenico Arcuri was the former extraordinary commissioner for the COVID-19 emergency. He was investigated for importation of 800 million masks from China during the firsts months of the coronavirus emergency. Arcuri was accused of embezzlement and abuse of office. The "#draghi", "#conte", "#salvini", "#renzi" hashtags can be noticed among the most important ones. They are all high-profiled italian politicians. A change of government occurred by the time. "#conte" left his position as Prime Minister and "#draghi" replaced him and a new government was formed.

In October 2021, "#trieste" was one of the cities where protests against the government and especially against "#draghi" and "#speranza" were held. Also on October 15, huge protests were held in "#roma", at "#piazzadelpopolo".

From November to December 2021, "Reinforced Green Pass" (or "#supergreenpass") was introduced as a new document by the government to fight against Covid. Meanwhile, "#omicron", which was a new variant of the Covid, was affecting people around the world and the third dose of vaccine was important for immunity at the time.

The date February 15 is crucial in the history of Covid. The reason is that from that day, the over 50 workers were forced to obtain at least the reinforced Green Pass ("#obbligover50").

**Figure 11.** Node degree for the period March - September 2020**Figure 12.** Node degree for the period January 2021 - May 2021**Figure 13.** Node degree for the period October 2021

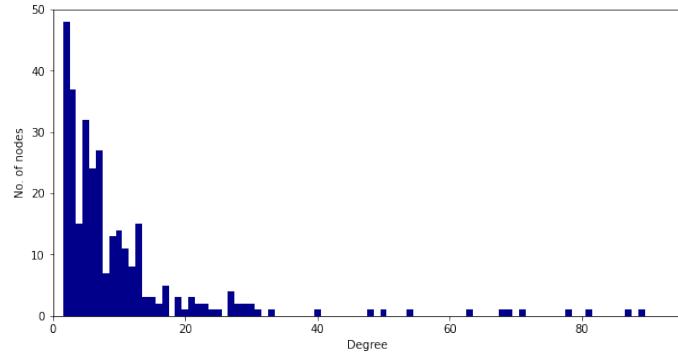
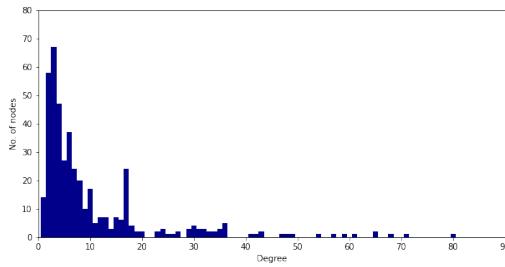
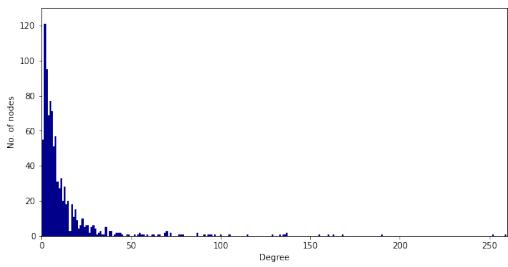
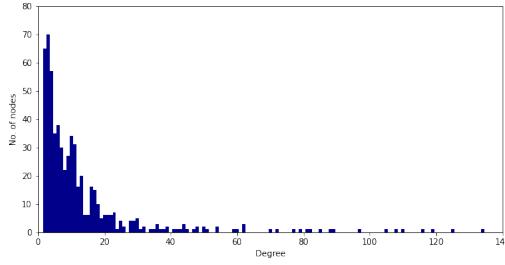
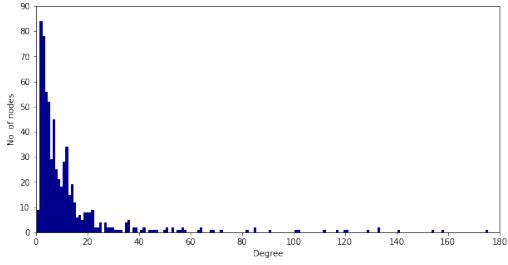
**Figure 14.** Node degree for the period November 2021 - December 2021**Figure 15.** Node degree for the period February 2022 - May 2022

5.5. Degree distribution

Degree distribution is a statistical description of the distribution of node degrees in a network. It provides information about the number of edges that are connected to each node, which is defined as the number of edges that are connected to it. The degree distribution is displayed as an histogram that shows the frequency of nodes with a particular degree in a network. By examining the degree distribution, one can gain insight into the structure of the network, including the presence of hubs (nodes with many connections).

5.6. Degree distribution Analysis

From the histograms we can observe that the degree distribution in all our five networks is very left-skew meaning that there are very few nodes with high degree (hubs) and many nodes with a small number of edges.

**Figure 16.** Local Clustering Pre-Vax**Figure 17.** Vaxcamp net**Figure 18.** October net**Figure 19.** Nov/Dec net**Figure 20.** 2022 net

5.7. Complementary Cumulative Distribution Function

The power law pattern is a mathematical relationship between two values, where one value is proportional to the power of the other value. In the context of networks, this relationship is observed between the number of connections a node has and the frequency of nodes with that number of connections. The power law distribution of connections in a network means that a few nodes have many connections, while most nodes have relatively few connections.

5.8. Complementary Cumulative Distribution Function Analysis

From the following graphs we can see that ours networks follow the power law and consequently we can consider them as scale-free networks.

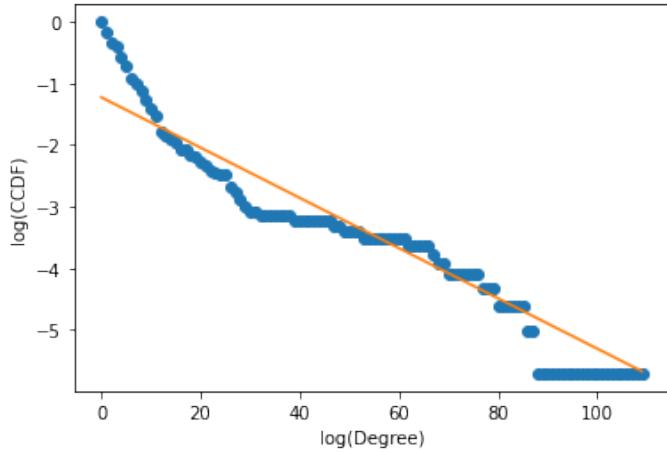


Figure 21. Complementary cumulative Density Function Pre-Vax

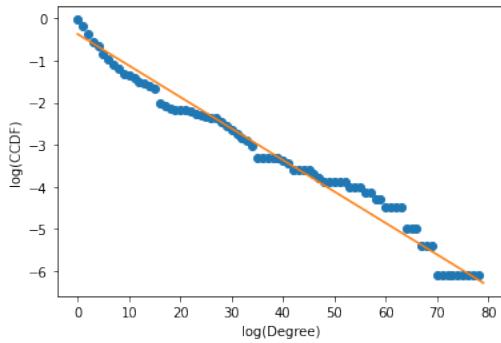


Figure 22. Vaxcamp net

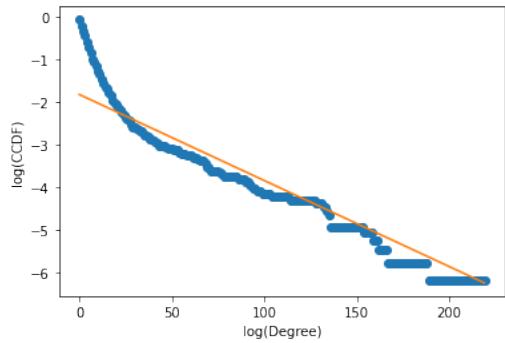


Figure 23. October net

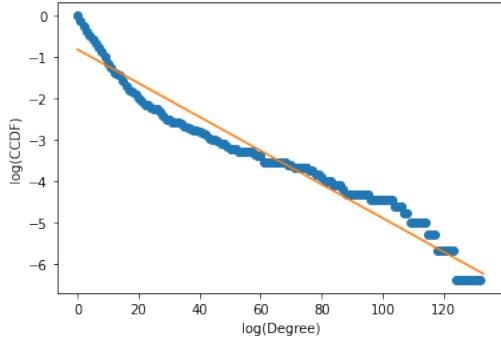


Figure 24. Nov/Dec net

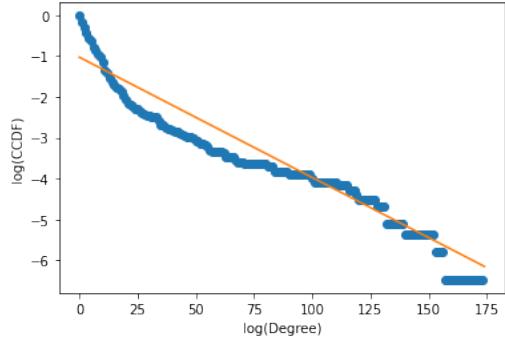


Figure 25. 2022 net

5.9. PageRank

PageRank works by counting the number and quality of links to a page to determine a rough estimate of how important the website is. The underlying assumption is that more important websites are likely to receive more links from other websites. PageRank is introduced by Page & Brin, as a vector that solves the following fixed point equation:

$$r = cMr + (1 - c)q$$

Where r is the PageRank vector (centrality), c is the damping factor, M is the (column) normalized adjacency matrix and q is the teleportation vector.

5.9.1. PageRank analysis

In this section, we shall undertake an analysis of the relative importance of hashtags across various temporal intervals. This will provide valuable insights into the public perception of the Covid-19 pandemic and its associated issues, as well as how these perceptions evolved over time. As depicted in the accompanying plots, one of the most salient hashtags in the early stages of the pandemic (let's say the vaccination campaign, during the first months of 2021) pertained to the topic of vaccination obligation (#obbligovaccinale). It was one of the most widely discussed topics among users at the time, since a lot of people on Twitter argued that it was a violation of personal freedom and rights, although the official position of the Italian government was that vaccination is highly recommended, but not mandatory (with some exceptions related to people's work, as is the case of health care personnel). However, as the data presented in plot 28 illustrates, this topic appears to have lost some of its relevance over time.

Another important area of discussion during the following period was the city of #trieste, where anti-vaccine protests had taken place in October 2021, in a period when the idea of some kind of document certifying vaccination and allowing entry into certain public spaces was gaining ground, generating widespread debate. Stefano Puzzer (#puzzler) was the leader of the protests against the government, since government was forcing people to take the Green Pass. At the end, he was evicted from the city ("#sgombero"). In subsequent intervals, we observed criticism directed at the government for what some users perceived as a health dictatorship and for mandating the wearing of masks in public spaces. These hashtags too appear to have lost their prominence as a new debate emerges among users, centered around the Green Pass policy ("#greenpass"). This hashtag and its counterpart, "#nogreenpass", come to occupy a central position in subsequent intervals. This new discourse pertains to the government's policy of granting access to events and gatherings based on one's vaccination status.

This analysis thus enables us to discern the evolution of public opinion, as well as the emergence and decline of various topical concerns. Furthermore, by comparing the relative importance of hashtags with other parameters, such as the level of hate associated with the correspondent tweets, we can gain a deeper understanding of how they are related to specific events and circumstances.

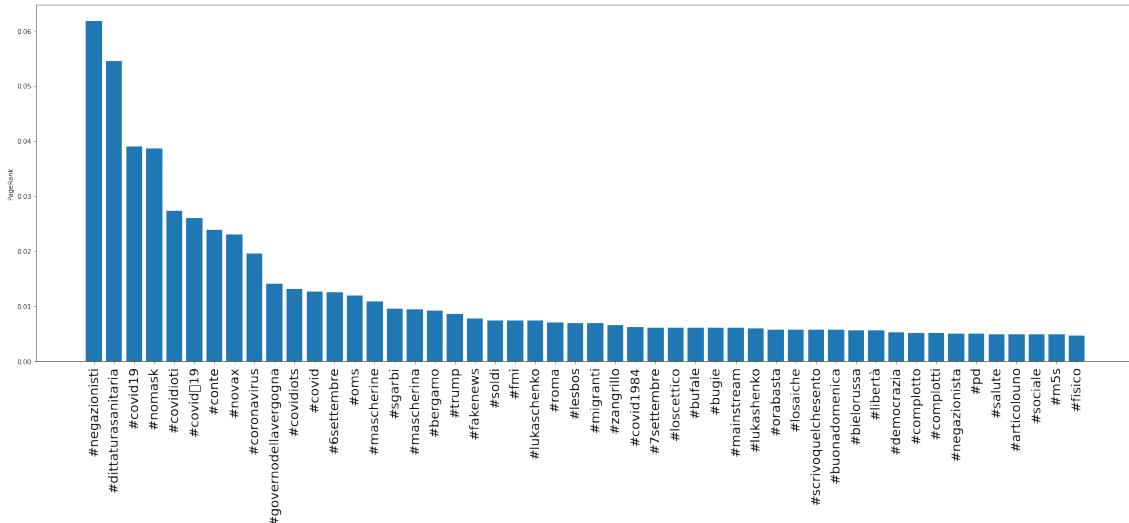


Figure 26. PageRank for the period March - September 2020

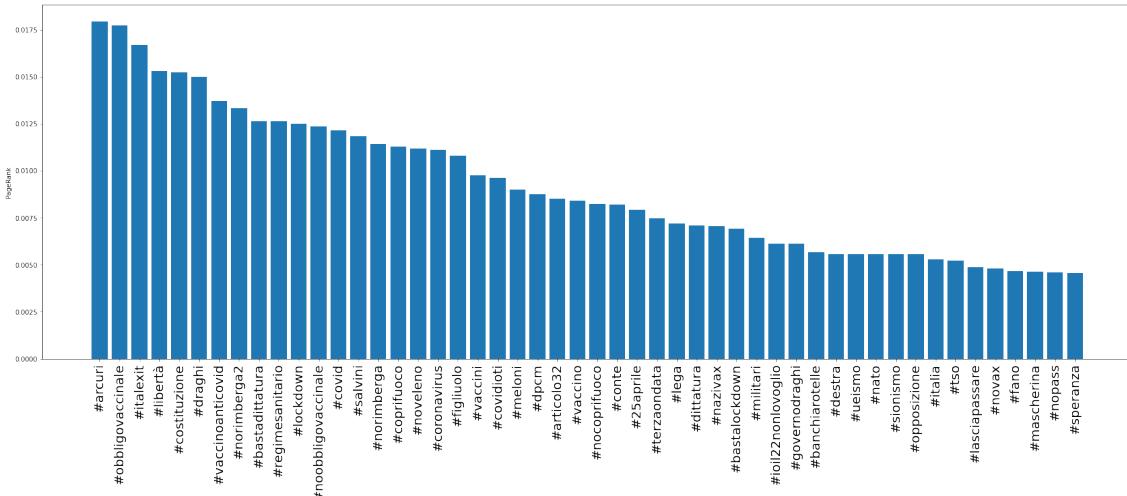


Figure 27. PageRank for the period January 2021 - May 2021

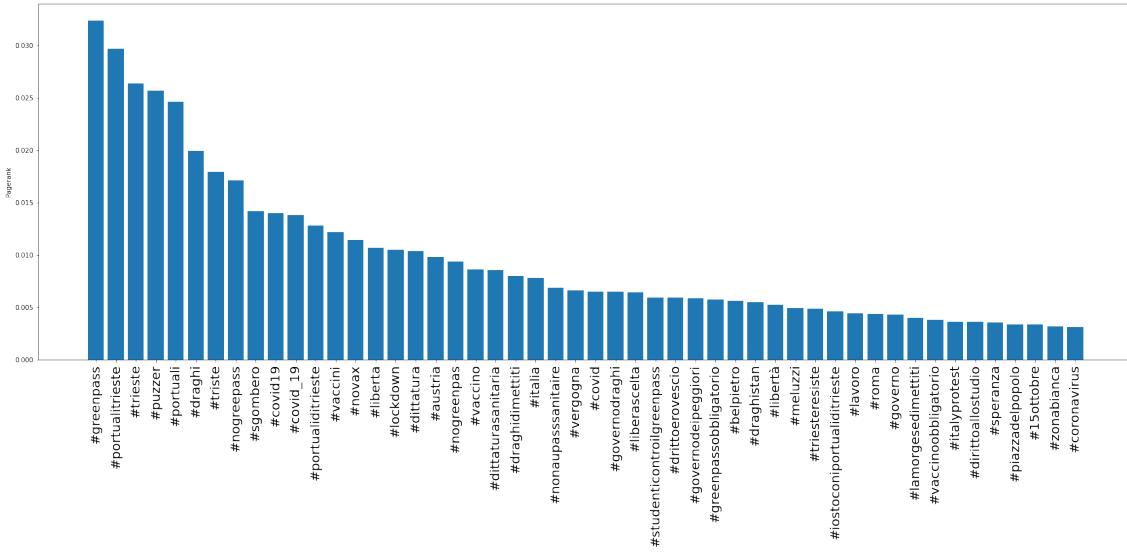


Figure 28. PageRank for the period October 2021

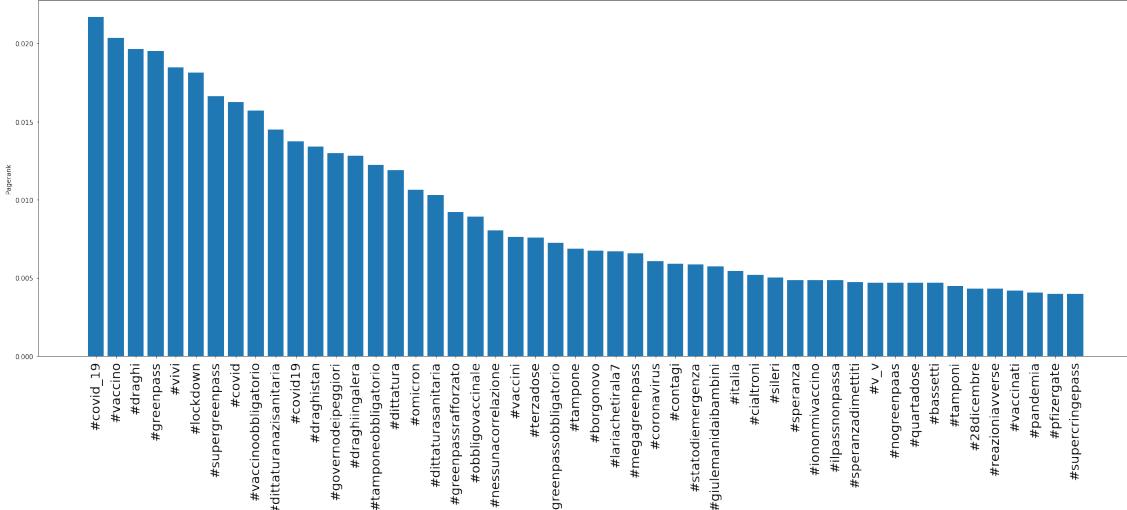


Figure 29. PageRank for the period November 2021 - December 2021

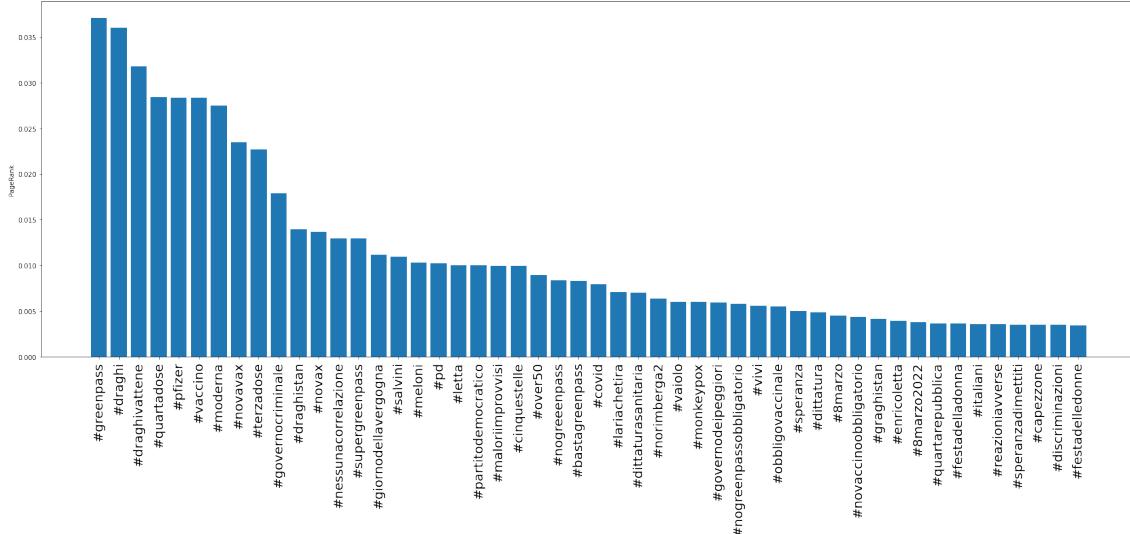


Figure 30. PageRank for the period February 2022 - May 2022

5.10. Betweenness

Betweenness centrality is a way of detecting the amount of influence a node has over the flow of information in a graph. It is often used to find nodes that serve as a bridge from one part of a graph to another. The algorithm calculates shortest paths between all pairs of nodes in a graph. Each node receives a score, based on the number of shortest paths that pass through the node. Nodes that more frequently lie on shortest paths between other nodes will have higher betweenness centrality scores. Betweenness centrality is implemented for graphs without weights or with positive weights.

$$g(v) = \sum_{s \neq v \neq t} \frac{\sigma_{st}(v)}{\sigma_{st}}$$

Where σ_{st} is the total number of short paths from node s to node t and $\sigma_{st}(v)$ is the number of those paths that pass through v .

5.10.1. Betweenness analysis

In the first fraction of time, it is evident from the graph that that of denials (#negazionisti) is again the most central hashtag. They were opposed to wear masks (#nomask) in the public spaces. In addition, they befooled people who believed in how dangerous the virus was, by calling them "#covididioti" and other similar terms. Draghi's government legislated a new "DPCM", in order to fight against the third wave (#terzaondadata) of virus. Although they set a new rule in the country by March 1st (#1marzo), which again divided regions into different zones according to the number of infections, and some of them had to be in "#lockdown".

In the following epoch, as it is noticeable from the plot 33, the discussions on Twitter were hinging around the protests in "#trieste" for abolishing the "#greenpass" by "#novax" people. The "#portualiditrieste" thought restrictions were extremes and they were a proof for health dictatorship (#dittaturasanitaria).

The debates on Green Pass were still going on, when a new document called Super Green Pass (#supergreenpass) was introduced by the Draghi's government in the period November- December. The hashtag "#governodeipeggiori" (or "worst people government") became one of the central nodes, as a sequence of the event occurred. Health dictatorship hashtag (#dittaturasanitaria) was still among the nodes with the highest betweenness. The "#novax"ers manifested their opinion about the restrictions with the hashtag "#nogreenpass". By the new rules, the over 50 employees had to obtain the Green Pass, in order to work in their workplace.

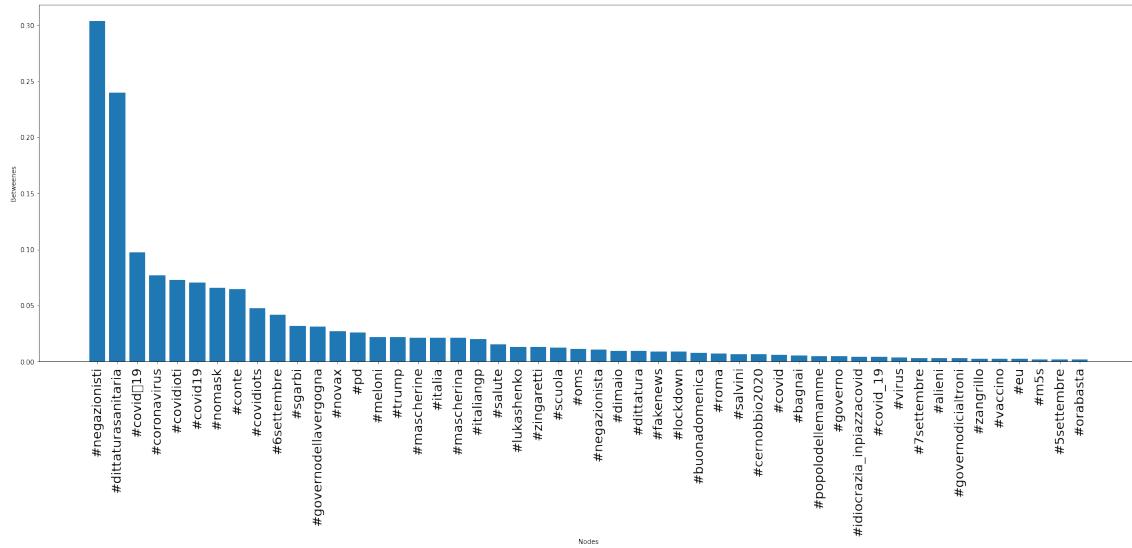


Figure 31. Betweenness for the period March - September 2020

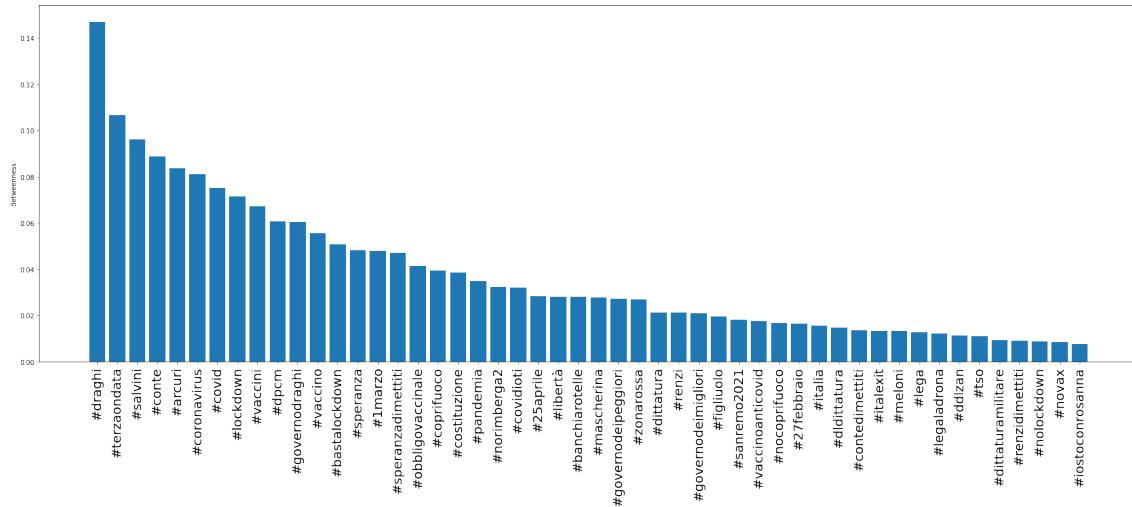


Figure 32. Betweenness for the period January 2021 - May 2021

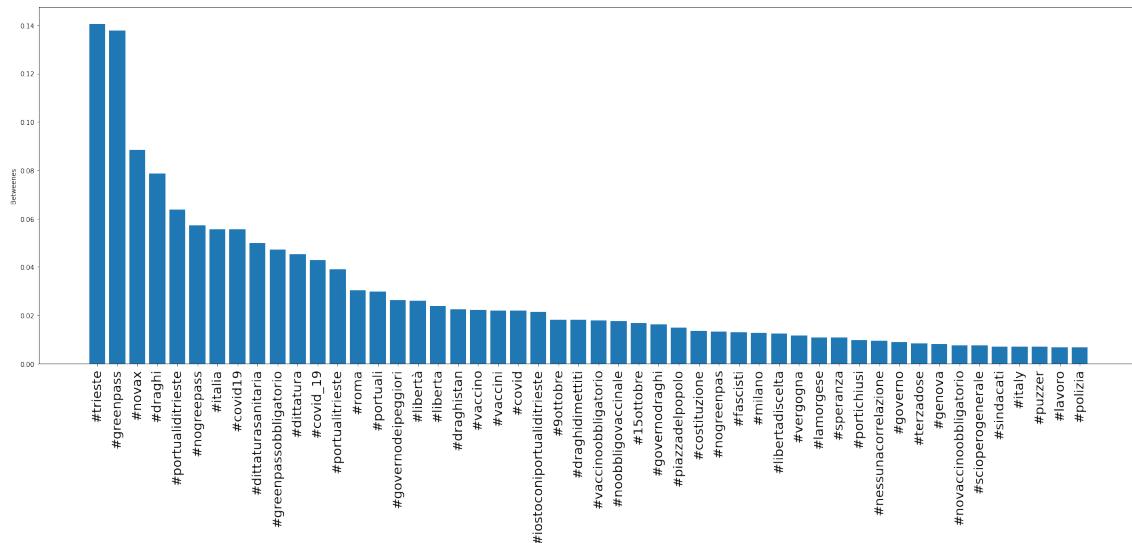
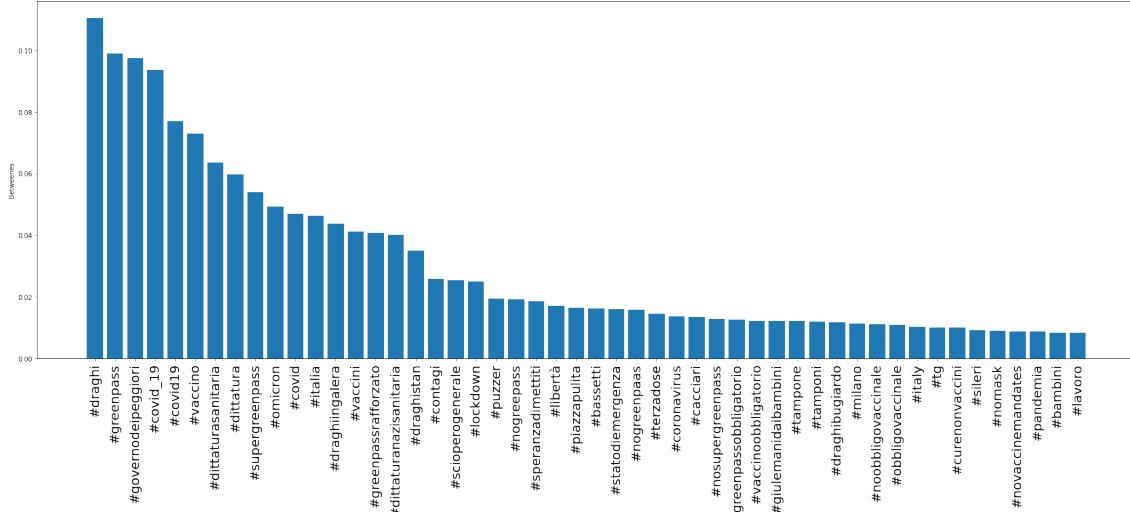
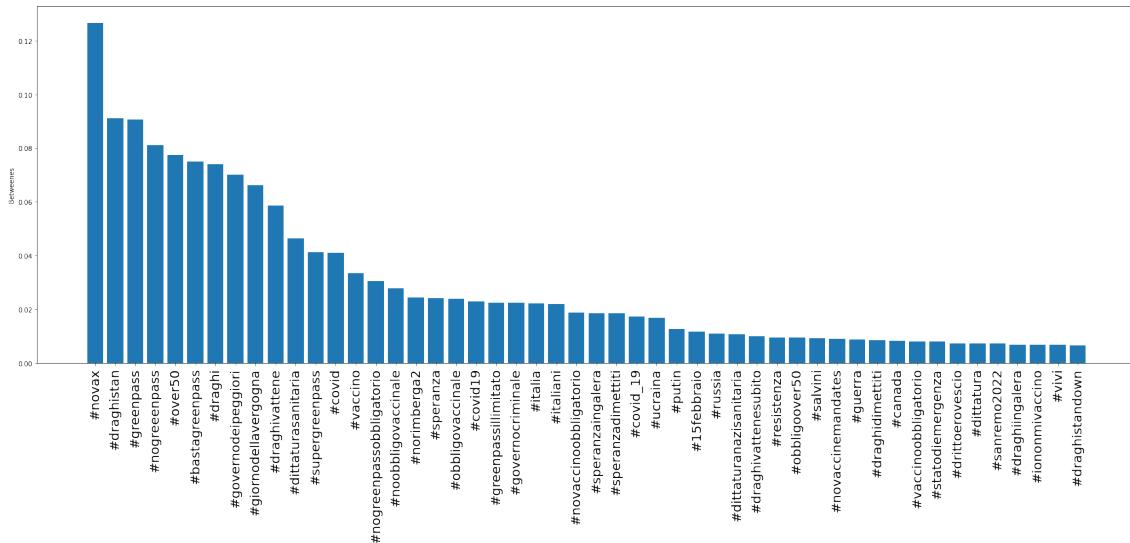


Figure 33. Betweenness for the period October 2021

**Figure 34.** Betweenness for the period November 2021 - December 2021**Figure 35.** Betweenness for the period February 2022 - May 2022

5.11. Closeness

In a connected graph, closeness centrality (or closeness) of a node is a measure of centrality of the network, calculated as the reciprocal of the sum of the length of the shortest paths between the node and all other nodes in the graph. Thus, the more central a node is, the closer it is to all other nodes. In other words, the easiest a node is to reach, the best it is for spreading information.

$$C(x) = \frac{1}{\sum_y d(x, y)}$$

Where the $d(x, y)$ is the distance (length of the shortest path) between vertices x and y ,

5.11.1. Closeness analysis

Performing the Closeness analysis enables us to have a superior vision about the hate speech during the global pandemic. Denials (#negazionisti) have the the highest value of Closeness, as the first graph illustrates. They were opposed to the idea of wearing masks (#nomask) in public. The idea of health dictatorship (#dittaturasanitaria) started from this period.

It seems that in the next period, the previous hashtags roughly disappeared and politicians such as "#draghi" and "#salvini" replaced them. The government decided to proceed with "#lockdown" policy. We can understand that the event mentioned was the main cause of hate speech towards the authorities on Twitter.

The analysis for October 2021 nearly remain the same, and we see that again the hashtags related to Trieste, dictatorship and mandatory Green Pass appear in the October plot. However, as the "#greenpass" hashtag endures in the succeeding time span, several old hashtags seems to be emerging again. "Draghi in prison" (#draghingalera), "Worst People Government" (#governodeipeggiori) and "#lockdown" indicate how the anti-vaccine community was disappointed by the council. In addition, "#omicron", the new variant of virus at that time, was spreading in the world. "#lockdown" was the solution implemented by the government to stand against the Covid. The criticisms towards the government and especially the Prime Minister "#draghi" are still there on Twitter. Hashtags like "#draghivattene" should confirm the situation previously explained. Hashtag "#nogreenpass" seems to be the main topic in the sense of Closeness analysis. No-vax people did not tolerate the fact the over 50 workers were obliged to get the Green Pass.

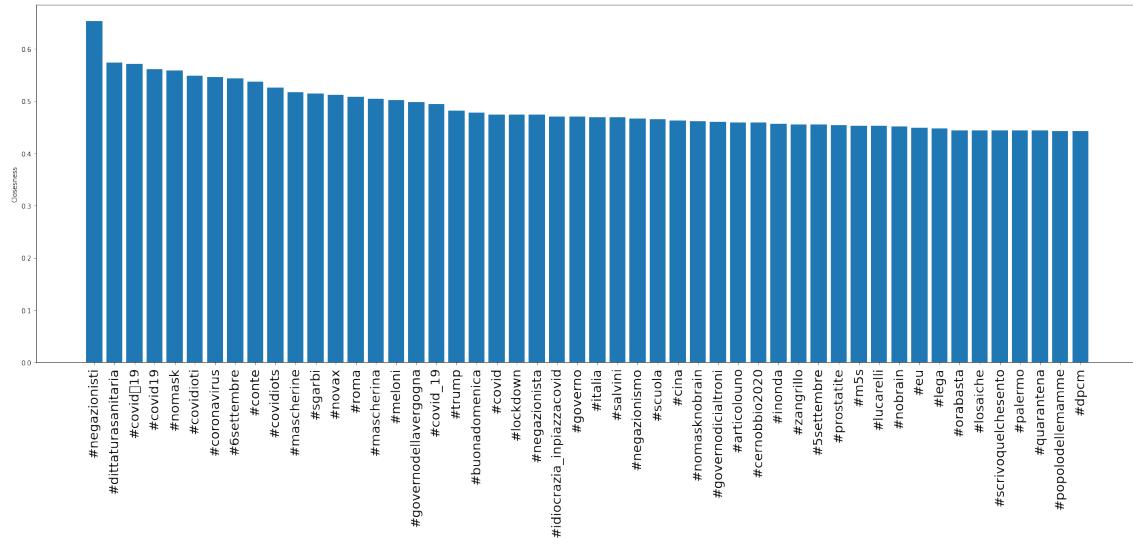


Figure 36. Closeness for the period March - September 2020

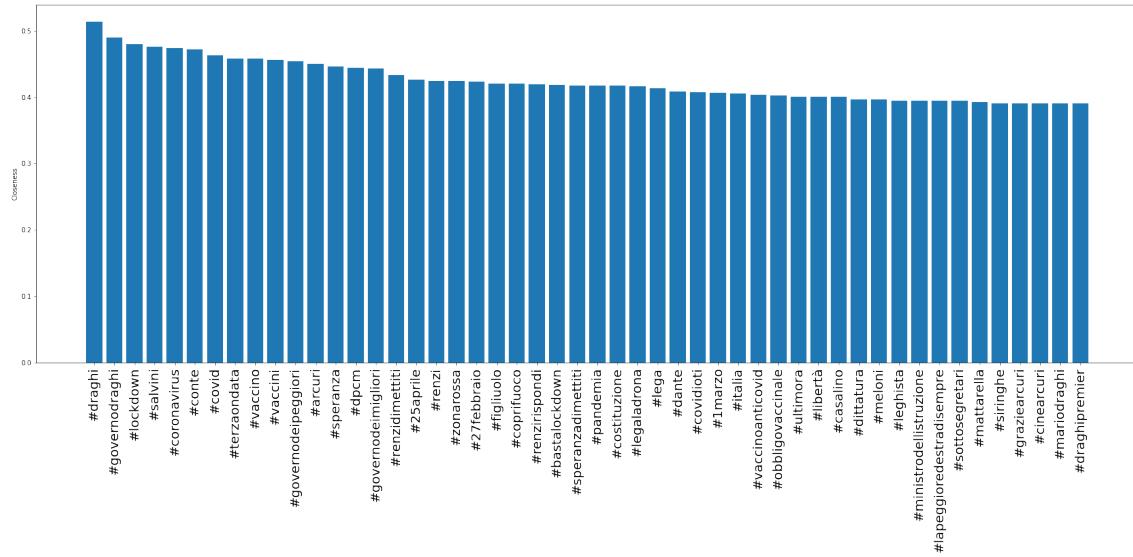


Figure 37. Closeness for the period January 2021 - May 2021

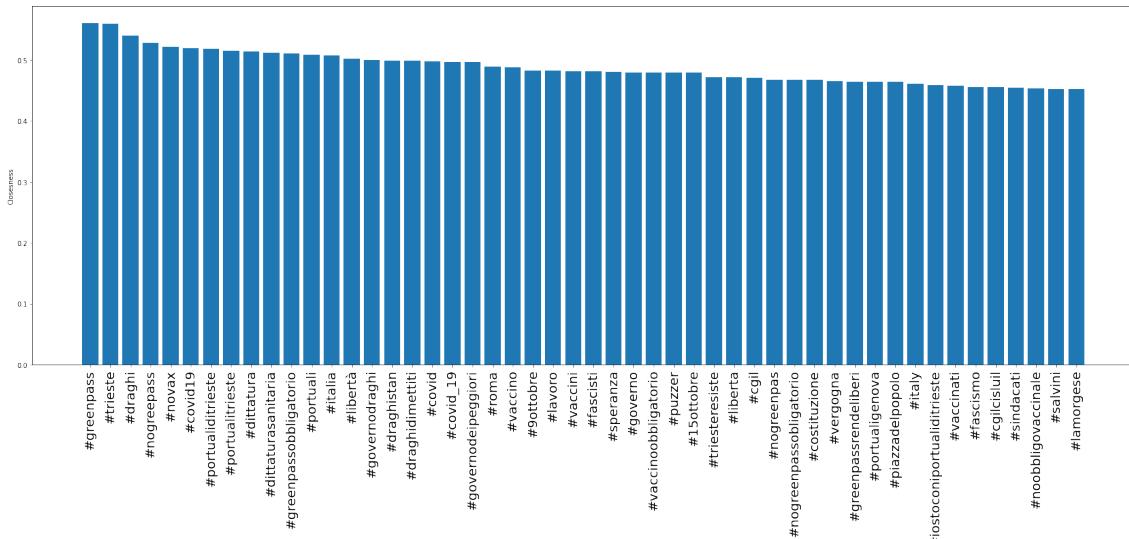


Figure 38. Closeness for the period October 2021

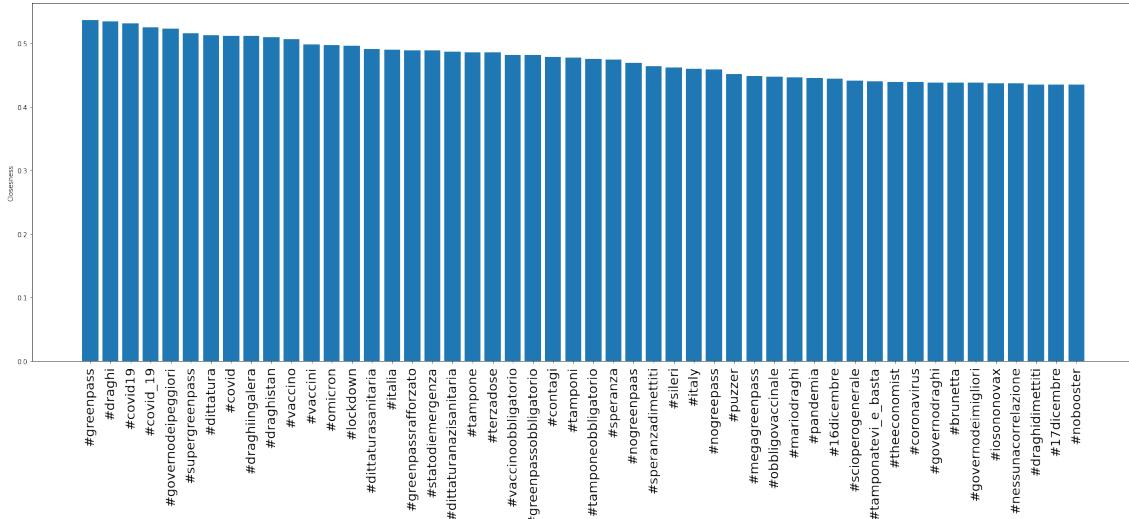


Figure 39. Closeness for the period November 2021 - December 2021

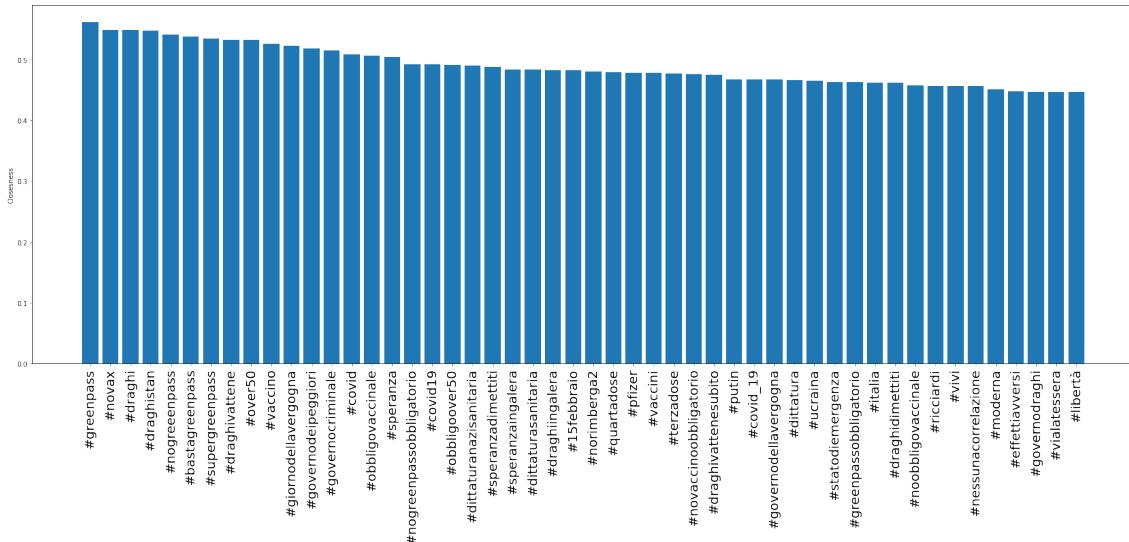


Figure 40. Closeness for the period February 2022 - May 2022

5.12. Global & local clustering coefficient

The global clustering coefficient measures the total number of closed triangles in a network. Indeed, L_i is the number of triangles that node i participates in, as each link between two neighbors of node i closes a triangle. Hence the degree of a network's global clustering can be also captured by the global clustering coefficient, defined as:

$$C_\Delta = \frac{3 \times \text{Number of Triangles}}{\text{Number of Connected Triples}}$$

The degree of a node contains no information about the relationship between a node's neighbors. The local clustering coefficient C_i , that measures the density of links in node i 's immediate neighborhood: $C_i = 0$ means that there are no links between i 's neighbors; $C_i = 1$ implies that each of the i 's neighbors link to each other. L_i represents the number of links between the k_i neighbors of node i . The local clustering coefficient of a random network is:

$$C_i = \frac{2L_i}{k_i(k_i - 1)} = p = \frac{k}{N}$$

5.12.1. Clustering coefficient analysis

For each of our 5 networks the local clustering coefficient has been computed for every node, employing the algorithm implemented in the Python *networkx* package. Additionally, the average clustering coefficient for nodes with the same degree has been computed, as well as the overall average coefficient for the entire network. The comparison between the clustering coefficients of the two networks is presented in Fig. 41 *et seq.* on a log-log scale. Blue dots indicate the local clustering coefficient for each node based on its degree, while the orange dots represent the average clustering coefficient for all the hashtags (nodes) with the same degree.

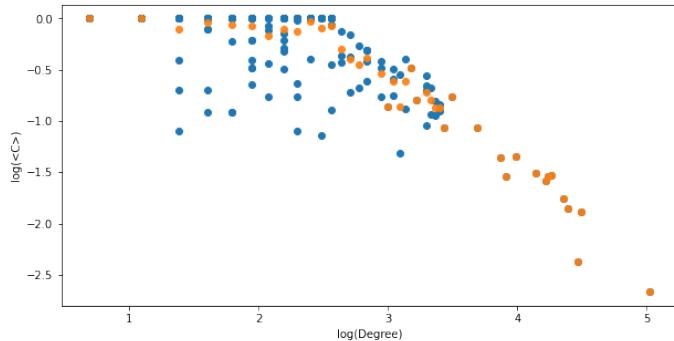


Figure 41. Local Clustering Pre-Vax

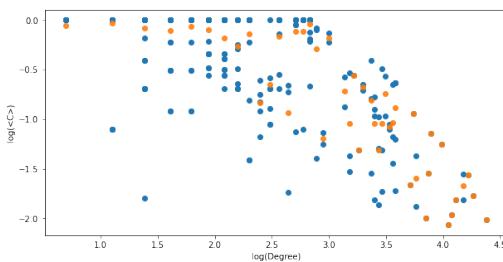


Figure 42. Vaxcamp net

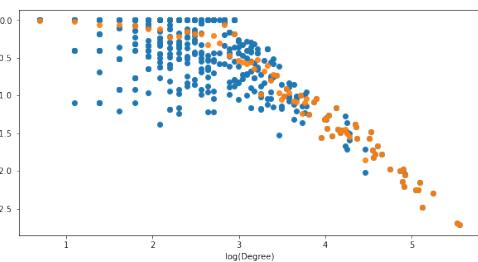
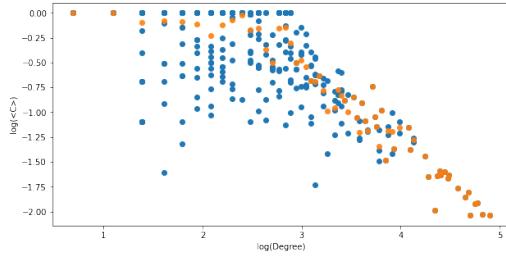
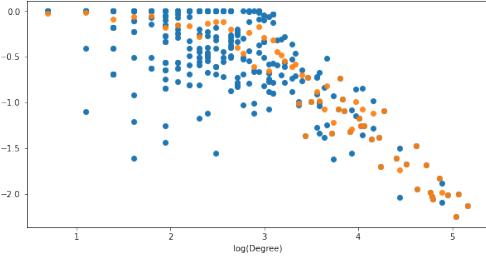


Figure 43. October net

**Figure 44.** Nov/Dec net**Figure 45.** 2022 net

From the plots it is possible to see that trend is quite similar in all the networks (with the partial exception of *Vaxcamp* network, whose dots look sparser, since it is the smallest one) and that nodes with a smaller degree have a higher clustering coefficients. Essentially, if a hashtag has a high degree, meaning it's connected to many others, its neighboring hashtags are not well connected to each other. On the other hand, hashtags with fewer connections tend to have neighbors that are more closely clustered. This can be interpreted like this: more general hashtags appear with a lot of hashtags that are not connected to each other, since, being cross-cutting, they catalyze much of the users' attention and appear very frequently; on the contrary hashtags that refer to some specific situation or event and have fewer connections tend to be clustered together.

The numerical results of the analysis, including the global clustering coefficients for the two networks, are summarized in Table 2.

Network	Global Clustering Coefficient	Average Clustering Coefficient
Pre-Vax	0.2866	0.8691
Vax-camp	0.3666	0.8152
October	0.2150	0.7814
Nov/Dec	0.2816	0.7981
2022	0.2453	0.8417

Table 2. Global clustering coefficients by network

From the table we can observe that the five network have similar global clustering coefficients and they are on the lower side; this means that those networks are quite sparse. On a local scale in each network most neighbor of the same node link to each other. This explain the high values for the local average clustering coefficient and the difference with the global clustering coefficient.

5.13. Assortativity

In assortative networks, the hubs tend to link to each other and avoid linking to small-degree nodes. At the same time the small-degree nodes tend to connect to other small-degree nodes. An extreme manifestation of this pattern is a perfectly assortative network, in which each degree- k node connects only to other degree- k nodes.

$$\ln(k_{n_n}) = \mu \ln(k_i)$$

The network is assortative if μ is positive.

5.13.1. Assortativity analysis

To evaluate the assortativity of the networks under consideration, we conducted a separate study based on degree, which is the most commonly used metric for assortativity. An algorithm from Python's NetworkX package has been used to calculate the assortativity coefficients through the Pearson correlation coefficient, in a range of [-1,1]. From the plots in Fig. 46 *et seq.* we can see that all the networks we are analyzing are disassortative, although this characteristic does not

seem to be very pronounced. It is noteworthy that the first period analyzed, i.e. the one before the vaccination campaign, is the one with the more negative value of assortativity, which seems to suggest that in that period the tendency of popular hashtags of being used in conjunction with less popular ones was a little bit more pronounced. In all the other plots the interpolation lines seem to be quite horizontal, so to better appreciate the differences between different networks we can rely on the Table 3.

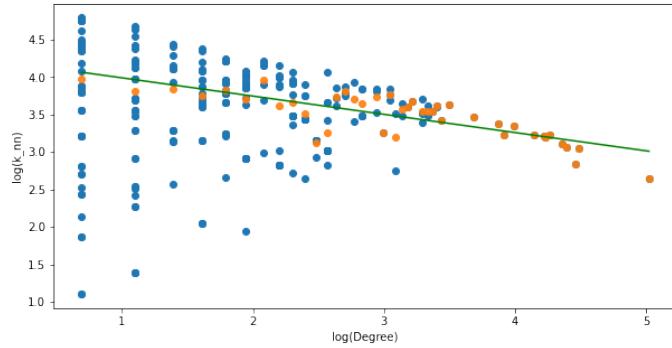


Figure 46. Assortativity Pre-Vax net

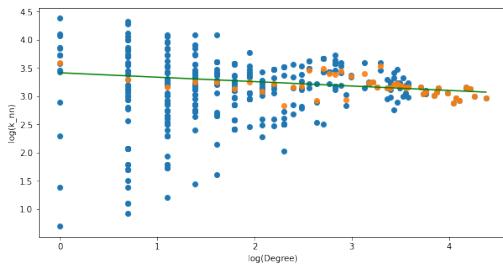


Figure 47. Vaxcamp net

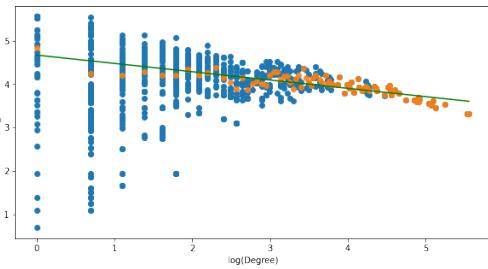


Figure 48. October net

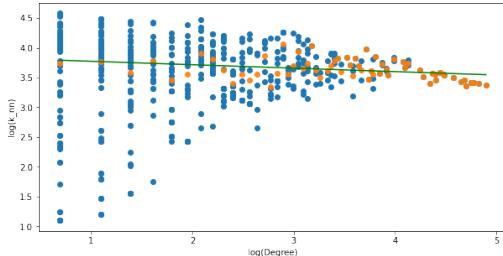


Figure 49. Nov/Dec net

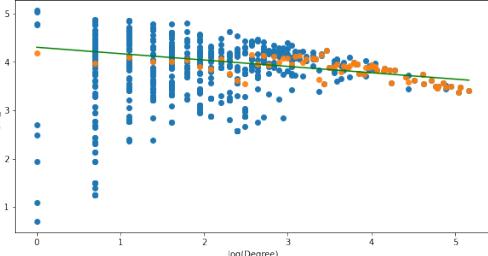


Figure 50. 2022 net

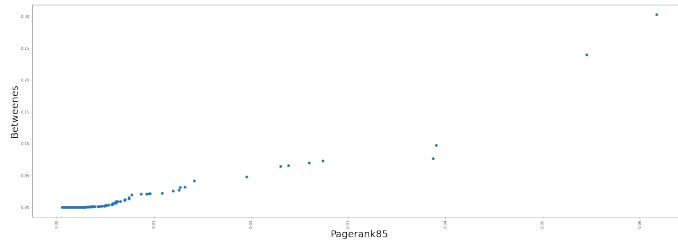
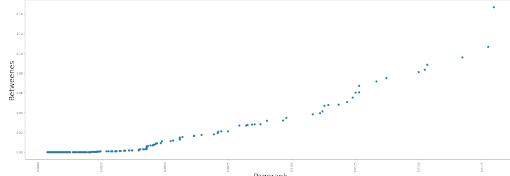
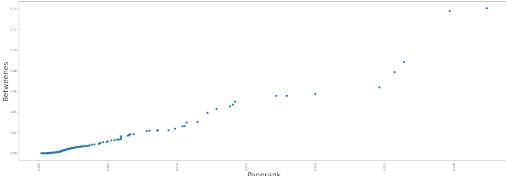
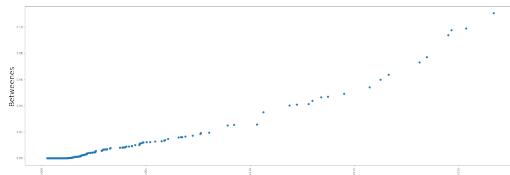
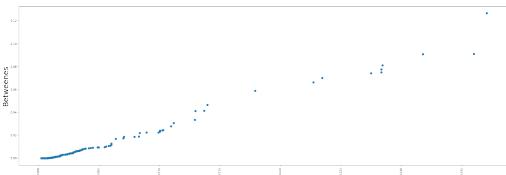
As already said and now shown by the Table 3 all the five networks have negative assortativity values. Moreover these values are all very close to zero, that implies a slight disassortative behaviour of the networks. In the end we conclude that there exist a mostly random mixing pattern. Since the five values here analyzed are relatively close to each other, we can say that the correspondent networks they behave similarly from the point of view of assortativity.

Network	Assortativity
Pre-Vax	-0.2151
Vax-camp	-0.0922
October	-0.1823
Nov/Dec	-0.1184
2022	-0.1547

Table 3. Assortativity value by network

5.14. PageRank VS Betweenness

The betweenness centrality for each vertex is the number of the shortest paths that pass through the vertex. Vertices with an high PageRank tend to be hubs. Since the network are disassortative, we tried to understand weather this property is reflected in the behavior of PageRank vs Betweenness. As expected there is a positive relation between the two centrality measures and it is illustrated by the following plots:

**Figure 51.** PageRank VS Betweenness Pre-Vax net**Figure 52.** Vaxcamp net**Figure 53.** October net**Figure 54.** Nov/Dec net**Figure 55.** 2022 net

5.15. Robustness

The robustness of a network refers to the ability to maintain its structure and function even in the face of internal changes, failures, or attacks, such as in case of node removals. A network that is considered robust is able to withstand changes in its connections or components without losing its overall functionality. In our robustness algorithm a node at a time is removed according to some specific order. The main goal is to find how many nodes should be removed in order to break the network.

5.15.1. Robustness Analysis

In the following we analyze robustness behavior of our five networks with respect to:

- Random Failure
- Attack

The term *Attack* refers to a strategy of removing nodes starting with the highest-ranking ones (hubs) so as to break the network into disconnected component more quickly and efficiently. In Fig. 56 *et seq.* results of the analysis are shown:

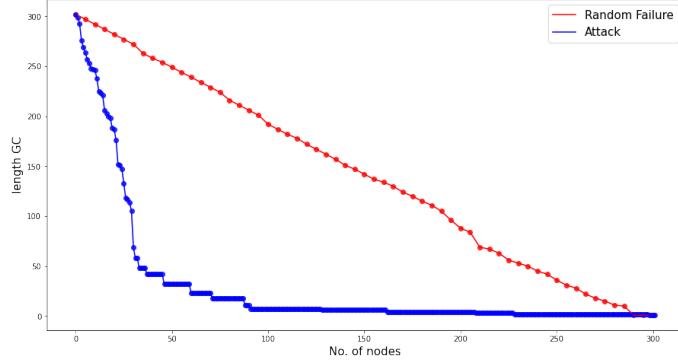


Figure 56. Robustness Pre-Vax net

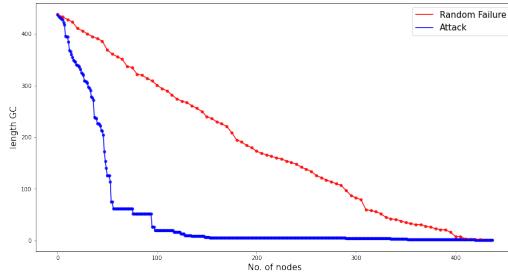


Figure 57. Vaxcamp net

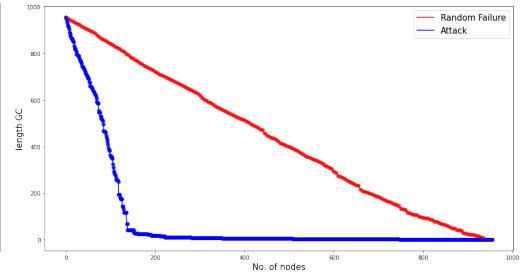


Figure 58. October net

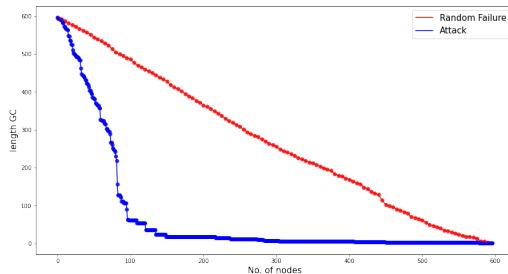


Figure 59. Nov/Dec net

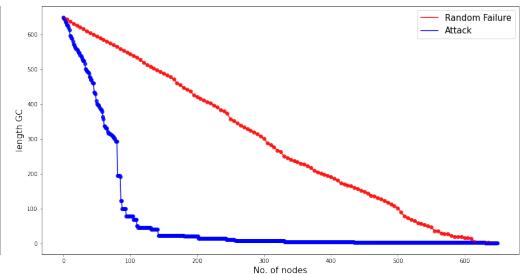


Figure 60. 2022 net

From the whole set of graph we can see that the behavior is quite similar in all the networks and when 20% of the nodes (in descending rank order) are removed all networks are almost disconnected, meaning that they are weak when exposed to a specific attack. In case of a random attack the behavior of all the network is in line with what we expected.

6. Communities detection (Louvain Algorithm)

When analyzing different networks, it may be important to discover communities inside them. The Louvain algorithm is a hierarchical clustering algorithm, that recursively merges communities into a single node and executes the modularity clustering on the condensed graphs. The inspiration for this method of community detection is the optimization of modularity as the algorithm progresses. Modularity:

$$Q = \frac{1}{2m} \sum_{ij} \left[A_{ij} - \frac{k_i k_j}{2m} \right] \delta(c_i, c_j),$$

is a scale value between -0.5 (non-modular clustering) and 1 (fully modular clustering) that measures the relative density of edges inside communities with respect to edges outside communities.

6.1. Communities analysis

Since is a greedy algorithm (Louvain's Algorithm) we ran it 6 times for each network and for the final result we select the ones with the highest modularity. We reported the different values of modularity:

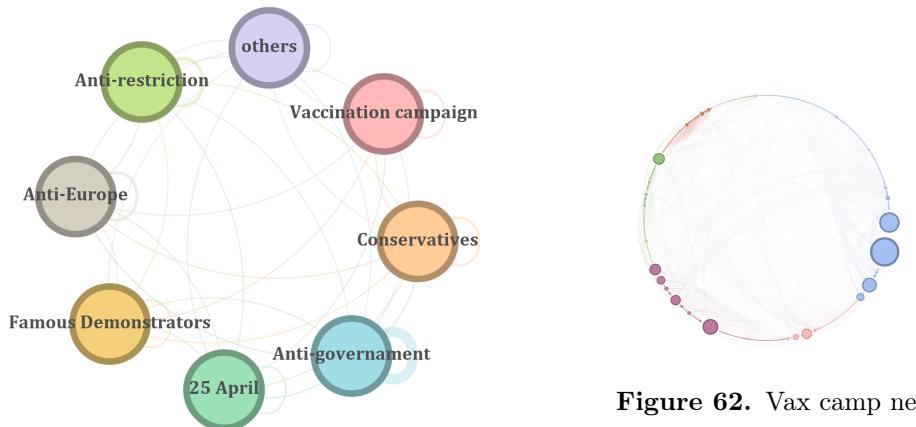
Network	Modularity
Pre-Vax	0.6425
Vax-camp	0.5465
October	0.5942
Nov/Dec	0.526
2022	0.222

Table 4. Global clustering coefficients by network

In the 2022 network we were not able to find a good community structure, but for the other fourth network we were. In the first network the prevax camp, the community were not related to the no vax community, actually the public debate at the time were not focused on this topic. So we focused on the 3 network in the middle period pre-vax, october and nov/dec. In the following pages we had three table. We built them in this way: there is a column with the name of the community, a brief description, another one with the most important hashtag (we ordered them with the PageRank) and as the last columns one tweets as an example to fix the idea.

6.1.1. January 2021 - May 2021

#	Community name	Description	Descriptive hashtag	Descriptive tweet
1	Anti-restriction	Against the covid restriction	#coronavirus, #italia, #novax, #nocoprifuoco, #oil22nonlovoglio, #tamponi, #difettosi, #svezia, #shock, #farsavirus, #bastacoprifouoco	@EnricoLetta Quello che non va è la stupida protervia con cui #PD, #M5s, #CTS e #DittaturaSanitaria chiudono gli Italiani agli #arrestidomiciliari e condannano intere categorie alla rovina con inutili #Coprifoucoalle22 e #lockdown: AVETE ROTTO I COGLIONI.. #oil22nonlovoglio #NoCoprifouoco
2	Vaccination campaign	Against the organizers of the vaccination campaign and the vaccination campaign in general	#conte#arcuri, #draghi, #figliuolo, #vaccini, #meloni, #conte, #militari, #sionismo, #opposizione, #video, #scienziati, #nobel, #contedimettiti, #pianovaccinale, #dittaturamilitare, #governodeimigliori	Emergenza affidata al #Figliuolo .. dopo non ci rimane che lo Spirito Santo.. #lockdown #DittaturaSanitaria
3	Conservatives	Against the covid restriction in general, but with a focus on Salvini and Lega.	#coprifouoco, #lockdown, #covid, #lega, #lasciapassare, #vaccino, #dpcom, #salvini, #terzaonda, #riaperture, #nolasciapassare, #breakingnews, #coronavirusitalia, #covidio, #zonarossa, #dirittoanonvaccinarsi,	Con #Salvini nel #GovernoDraghi le chiusure sono aumentate!!! Ma la @LegaSalvini non era quella del riapriamo tutto? Ah già dimenticavo che il suo leader lo chiamano il #cazzaroverde. Elettori della #Lega SVEGLIASTEVI! #DittaturaSanitaria #governodeipeggiori
4	Anti-governament	conspirators against the covid restriction.	#costituzione, #norimberga2, #libertà, #bastadittatura, #regimesanitario, #noobbligovaccinale, #norimberga, #noveleno, #articolo32, #nazivax, #nopass, #nogreenpass, #noue, #speranzaavattene, #speranzaingalera, #28maggio, #oppofinzione	Ormai non servono più né numeri (tutti farlocchi) né prove: è solo una #dittatasanitaria che mira al guadagno. #Norimberga2
5	25 April	Against the restriction, with a focus on 25 of April (Liberation day)	#25aprile, #nolockdown, #dittatura, #iapro, #antifascistisempre, #festadelaliberazione, #liberitutti, #politicamentecorretto, #liberta, #mattarella, #resistenza, #zonagialla, #regioni, #25aprire, #fasciopiddini	Festeggiare il #25aprile durante un regime nazifascista è davvero il massimo dell'idiota. #COVID-19 #DittaturaSanitaria #Nazifascismo #BastaCoprifouoco #bastalockdown
6	Famous Demonstrators	Against health ordinances against no vax character who have become famous as the student of Fano and Rossana	#ts0, #fano, #mascherina, #speranzadimettiti, #iostoconrosanna, #fatemiunsto, #dldittatura, #chivasso, #imbavagliati, #bambini, #greenpass, #gulag, #sudtirolo, #brunico, #rosanna	Ci sono giorni in cui anche i muri capirebbero che, a furia di negare la #dittaturaSanitaria, questa è diventata conclamata. Per esempio oggi, con due notizie: Fano: #FatemiUnTso Chivasso: #iostoconRosanna
7	Anti-Europe	Community against the restriction, related to an anti Europe party called Italexit	#obbligovaccinale, #vaccinoanticovid, #italexit, #covidio, #falsapandemia, #fakepandemia,	Lo dissi a Maggio 2020, ma voi DURI. Non ci fanno uscire più, se noi ci ribelliamo. Ci vuole una rivolta di piazza, ma seria, duratura, lunga anche mesi, dove i politici li andiamo a prendere. Altrimenti NON SI ESCE. #Italexit
8	Others	We were able to identify other community but there were not connected with the No vax speech	#polizia, #sanremo2021, #fiorelloamadeus, #gratis, #penadimorte, #collaborazionisti, #libri, #eclissarsi, #rigore	—

**Figure 61.** Vax camp communities

As we can notice, the first network has 7 relevant communities related to the no-vax speech, ordered like this: Anti-restriction, Vaccination campaign, Conservatives, Anti-government, 25 April, Famous Demonstrators, Anti-Europe. The last row is called "Others" since the other communities we were able to identify were not related to the anti-vaccine topic and then we decided to group them all in one last generic community.

The first community does not have a precise focus, in fact it is composed by no-vax who complains about restrictions. The *Vaccination Campaign* community was against the vaccination campaign and the government in general. Within it people complain did not concern the efficiency of the service, but its same existence, this is the reason why we identify them as anti-vaccines. The firsts three hashtags are: Arcuri (the first organizer of the vaccination campaign), Draghi (Italian Prime Minister as of 13 February 2021) and Figliuolo (an Italian army corps general, that replaced Arcuri). That's why some of the hashtags we found seem to be related to the military sphere. The *Conservatives community*, as well as the first one, is related to the restriction measures, with a specific focus on the political party Lega, which at the time was in the viewfinder of the no-vaccines. The main reason is that for years Lega (previously Lega Nord) was an extremist party, although during this period it was transforming into a more moderate one, thus displeasing the no-vaccines (usually more politically extremist), which attack it. We could find that this community was composed by no-vax people, because on top of the hashtags there was #vaccino (Vaccine), #dirittoanonvaccinarsi (right not to get vaccinated) etc.. Also the following community, *Anti government*, complains about restrictions, whit a conspiracy focus. In fact in this community there is a parallelism with the Nuremberg Trial. Like after the World War II with the representatives of the Nazi Germany, the no-vaccines, would have liked to bring to trial those leaders who imposed the restrictions. The hashtags #regimesanitario (health regimen), #noobbligovaccinale (no vaccination obligation) etc.. lead us to the conclusion that also this community is composed of no-vaccines. The community *25 April* was a specific time focused community. The 25 April it is the day on which the liberation from the Nazi-fascism is celebrated. The no-vaccines made the analogy with the Fascist dictatorship and the current government that imposed to them sanitary restriction. The *Famous Demonstrators* community was focused on people like Rosanna Spatari or the Fano student, who became famous during the vaccination campaign for their protests against it. The last community is the *Anti Europe*, which we named so in connection with the fact that many tweets are related to an italian political party called "Italexit" (founded by Gianluigi Paragone during this period). This party is strongly related to the anti Europeanism (the suffix "exit" stands for exit from the European Union) and no-vax groups. We could actually found hashtags such as #obbligovaccinale (vaccination obligation), #fakepandemia and others that confirm the category's membership in the no-vax domain.

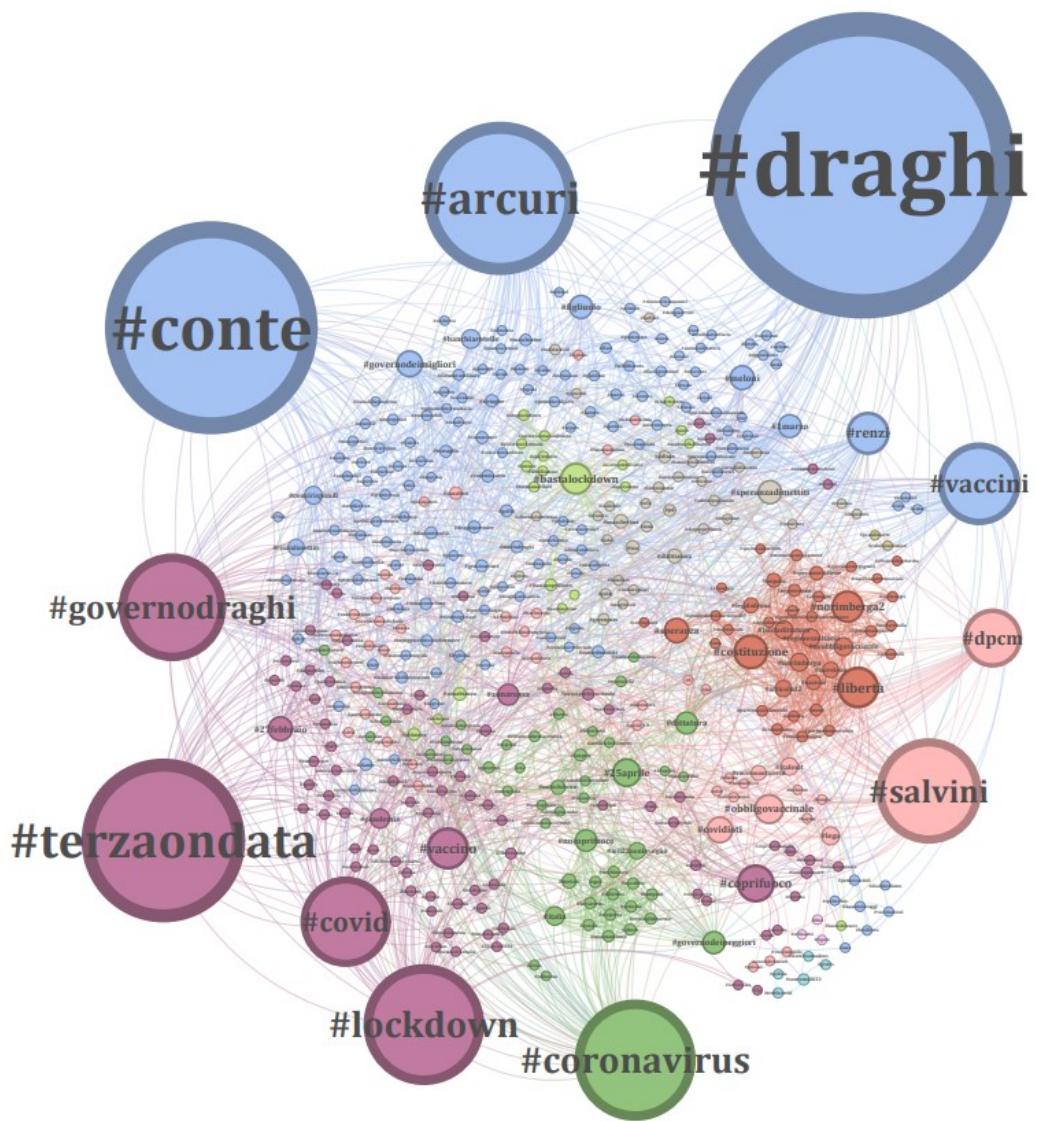
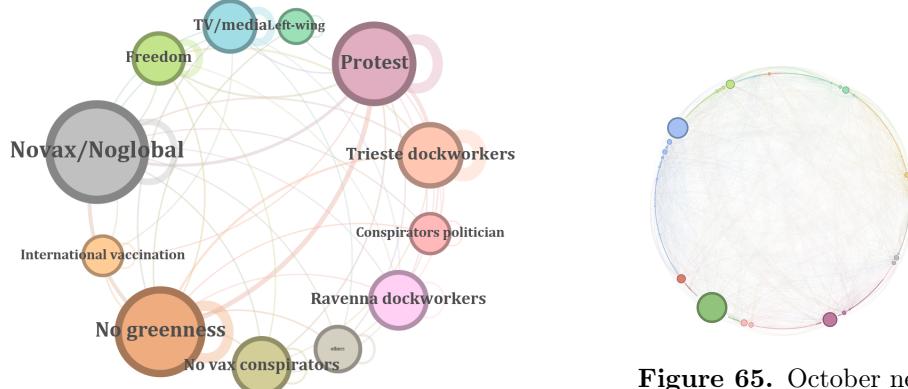


Figure 63. Vaxcamp

6.1.2. October 2022

#	Community name	Description	Descriptive hashtag	Descriptive tweet
1	Protest	The topic is about many protest that were in the Month of october	#trieste, #portualidistrieste, #dittatura, #novax, #dittatarsanitaria, #draghidimettiti, #roma, #lamorgesedimettiti, #piazzadelpopolo, #costituzione, #cgil, #portualigenova, #noobbligovaccinale	I #lavoratori attaccano e assaltano i #sindacati. #Draghi, a capo del #Governo, loda ed è in sintonia con i sindacati. Ma... tutt'apposto????? #vogliounmondomigliore #lavoro #governoDraghi #Roma #9ottobre #NoGreenPassObbligatorio #nogreepass #diritti
2	No vax conspirators	No vax complist groups	#fascista, #media, #nwvo, #mainstream, #fusani, #agamber, #lasciapassare, #giletti, #fateschifo, #cacciari, #disinformazione	Caro #piddino euroinomane, non tutto il Mondo è Toscana ed Emilia Romagna. #BASTADITTATURA #DITTATURASANITARIA #ITALEXIT #NOUE #NONWO #NoGreenPassObbligatorio #greenpass #Covid19
3	No greenness	Generic protests against the greenpass	#covid19, #covid_19, #draghi, #nogreepass, #nogreenpas, #vaccino, #covid, #vergogna, #dirittoallstudio, #ddlzan, #speranza, #pfizer,	"Non voglio prestarmi a questo ricatto" Il Green Pass non piace al noto compositore e pianista Mario Mariani che ha deciso di annullare i suoi cinque concerti Italiani per andare a suonare all'estero:
4	International vaccination	Community about international vaccination campaign	#vaccinazione, #vaccinazioni, #antipass, #antivax, #moldavia, #bulgaria, #ucraina, #montenegro, #estonia,	In #Ucraina, #Moldavia e, tendenzialmente, in tutti i paesi dell'est Europa manca la sollecitazione governativa alla prevenzione. Di norma, appena il 20% è immunizzato.
5	Novax/Noglobal	No vax no global	#greenpass, #lockdown, #austria, #greenpassobbligatorio, #governodraghi, #g20, #governo, #g20summit, #g20italy, #g20leaders	Praticamente i #G20 vengono a controllare come procede l'esperimento di ricatto e controllo sociale. #NoGreenPassObbligatorio #iostocopuzzer
6	Freedom	This community complains about freedom taken away	#liberta, #nonaupasssanitaire, #liberascelta, #studenticontrollgreenpass, #italyprotest, #lavoro, #manifestation23october, #diritti	Che figura agli occhi del mondo intero! Idranti contro un popolo che sta manifestando x togliere impedimenti x recarsi al lavoro senza limitazioni .. #nogreenpassobbligatorio ... #liberta'... lottando x il diritto libero sacrosanto al lavoro #Trieste #portuali coraggiosi
7	TV/media	About Italian Television	#vaccini, #meluzzi, #drittoevescio, #belpietro, #zonabianca, #caprarica, #sieromagico, #sileri	#Pregliasco spiegando ..prova di convincere le persone a vaccinarsi... penso che il risultato è proprio opposto.. #DrittoeRovescio #nogreenpass #NoGreenPassObbligatorio #portualidiTrieste #portichiusi
8	Left-wing	This community complains with the left-wing	#sinistra, #papastro, #cei, #sacerdoti, #feccia, #comunistarda, #bolsonaro, #facciamorete, #sardine, #m5s, #pdnetwork, #antifascismo, #nazismo	@CottarelliCPI LaCosa più incredibile Squadrismo sembra #sindacati #sinistra che invoca vecchie paure #fascisti pr Disunire Disgregare Distogliere attenzione veri Problemi #novax #NoGreenPassObbligatorio #nogreepass #Cgil #CgilCislUil
9	Trieste dockworkers	About the dockworkers in Trieste	#portualidistrieste, #portuali, #triste, #puzzzer, #sgombro, #telekabul, #cctv, #robadamatti	Per la prima volta nella mia vita mi trovo ad essere d'accordo ad uno sciopero #portualidistrieste #Draghidimettiti #NoGreenPassObbligatorio
10	Conspirators politician	Politicians from the mixed group	#barillari, #cunial, #laditturanonsapetecosasia, #17ottobre, '#nomask, #kimjungun	#Barillari e #Cunial davanti al Consolato svedese: "Chiediamo asilo". In effetti non sono pronti nemmeno per la prima elementare. #NoGreenPass #NoGreenPassObbligatorio #novax #17ottobre
11	Ravenna dockworkers	About the dockworkers in Ravenna	#portichiusi, #fincantieri, #unive, #ravenna, #portualiravenna, #merlino	A #ravenna si parte! Appuntamento domani mattina ore 7.00 al Varco TCR #NoGreenPassObbligatorio #NoGreenPass
12	Others	We were able to identify other community but they were not connected to the no vax speech	-	-

**Figure 64.** October communities

This table is about the communities of the October period. At that time there were along all the Italian peninsula protests against the enactment of the Green Pass (a document that assesses if you are vaccinated or not) for some activity like the use of public transports, the possibility to get into public spaces like restaurants or work places and so on. In other words it was not mandatory to be vaccinated, but in this case people daily lives could be widely constrained. The first community is about protests (#trieste, #ravenna, #roma...) against the Green Pass. Like in the previous network we meet here the conspiracy community, that still uses the metaphor of the Fascist regime. The third community is a sort of time evolution of the Anti-restriction community from the previous network. The reason is quite simple: during the vaccination campaign period restrictions were not identified with the Green Pass since it was not mandatory. This is why no-vax people complained against generic restrictions, while in October 2021 they could identify restrictions with the Green Pass. The fourth community is made of people concerned about the vaccination process in the east Europe, and we decide to include it in our analysis since it was well defined, although it was quite small. *NoVax/NoGlobal* community is a highly time-specific community since connects the G20 summit, which was perceived as a symbol of the establishment that constrain no-vaccines to their "fate", with the no-vax community. The sixth community is focused on the topic of Freedom, complaining about how much it was being taken away from them. The *TV/media* is about television shows, as we can infer from the presence of the hashtags "Diritto e Rovescio" and "Zona Bianca" at the top of ranking. This talk-shows were famous for "listening to everyone's opinion", therefore hosting no-vaccines and pro-vaccines complaining about thoughts that were not aligned with theirs. Since frequently no-vaccines put their thoughts on Twitter, we could detect this community. The *Left-Wing* community was focused on the no-vaccines complaining about the centre-left Italian parties, as the most important hashtags are #sinistra (left) and #pdnetwork (PD is a center-left party). The ninth and the eleventh communities were specifically about the dockworkers, respectively of Trieste (first one) and Ravenna (second one). The Trieste community is actually bigger than the Ravenna one, since at the time the protests of the dockworkers in Trieste were probably the largest in Italy against Green Pass. During that period people like Stefano Puzzer, the leader of the protest became really famous across the no-vax community, and this is the reason why it appears also in other communities, as the *NoVax/NoGlobal* one. Finally the tenth is a small community focused on Davide Barillari and Sara Cunial, two ex-members of M5S, an Italian political party, from which they quit because of their extremist positions, ending up in the "mixed-group".

Figure 65. October net

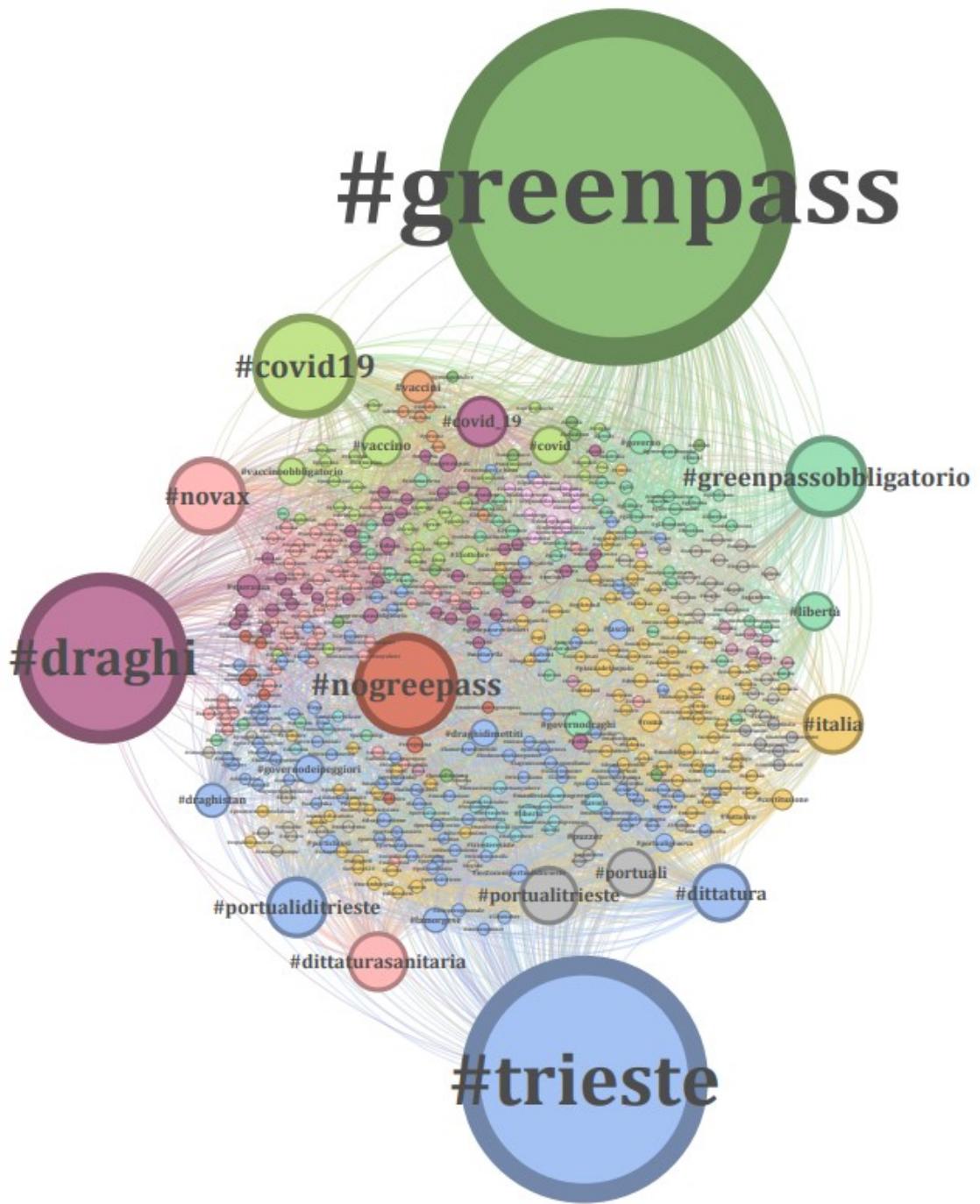
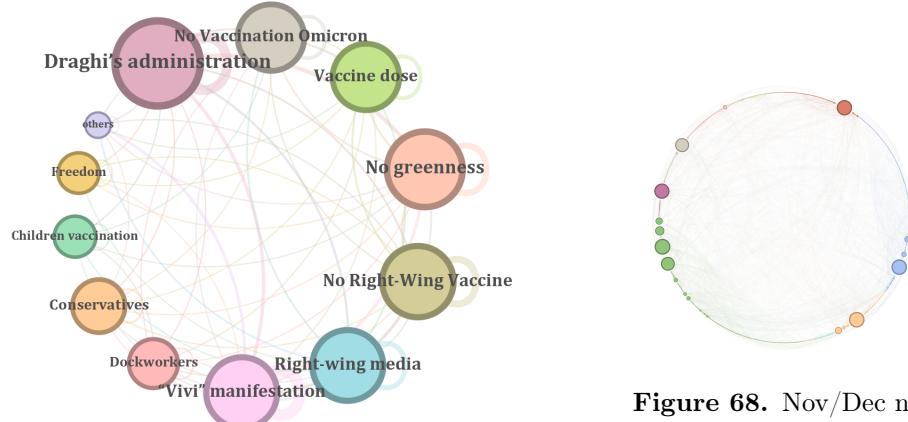


Figure 66. October

6.1.3. November 2022- December 2022

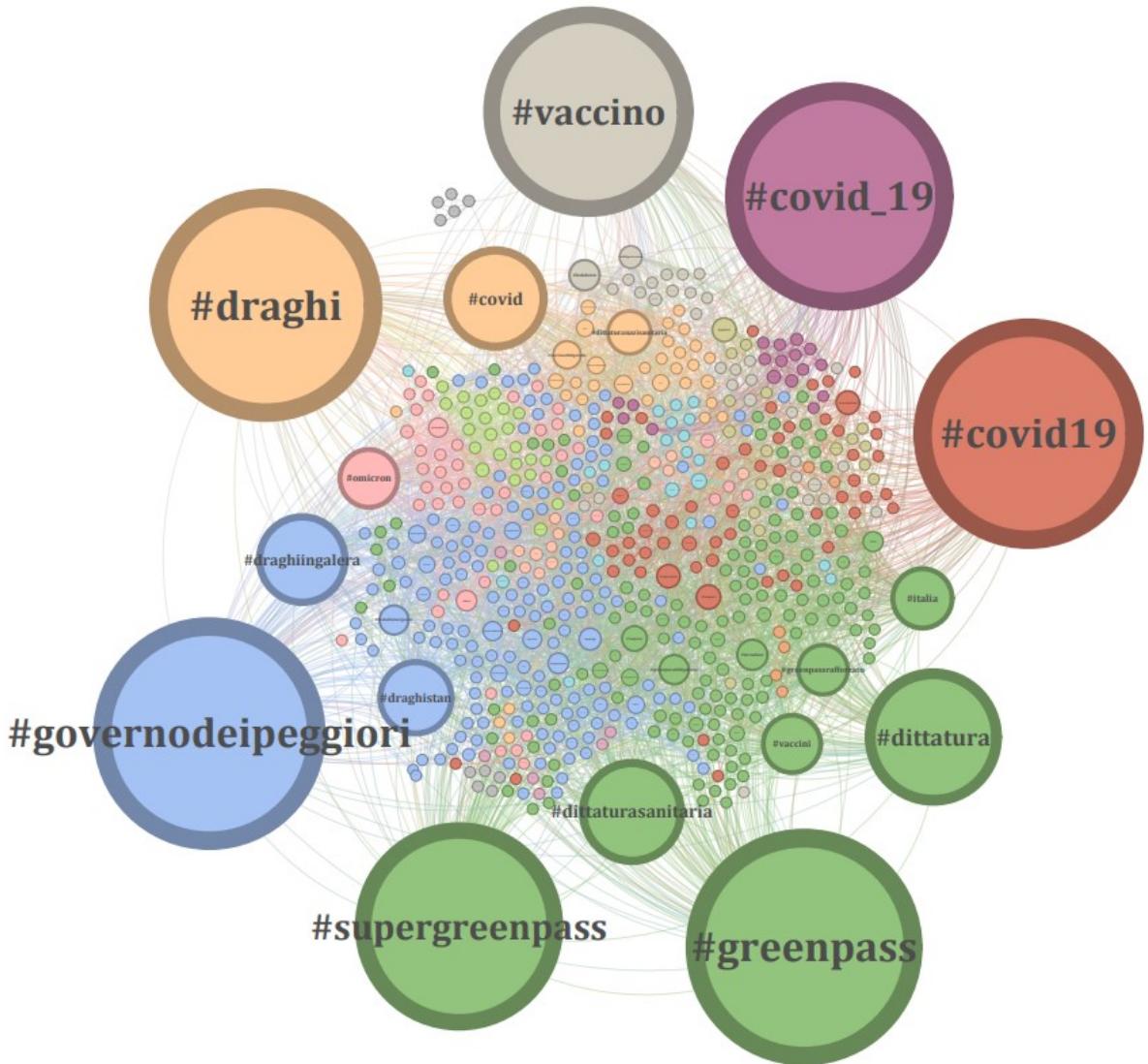
#	Community name	Brief description	Descriptive hashtags	Descriptive tweets
1	Right-wing media	Media with a focus on the right wing	#covid19, #coronavirus, #28dicembre, #cruciani, #lazanzara, #confindustria, #bonomi, #nogreepass, #quarantena, #parenzo, #covid19italia, #tamponi, #meloni, #fratelliditalia	Momenti difficili x chi sostiene che in #italia c'è la #dittaturasanitaria muti #cruciani #Borgonovo #Belpietro e i vari #Novax televisivi tutti rigorosamente #vaccinati (x fortuna)
2	Draghi's administration	Against Draghi's government	#draghiingalera, #draghistan, #governodeipeggiori, #bassetti, #speranza, #speranzadimettiti, #draghibugiardo, #governodraghi, #brunetta, #scanzi, #ipocondriaci, #draghidimettiti, #draghi_minaccia_per_l_italia, #traditore	Signori e signore exco a voi la #dittatura #Draghistan #NoGreenPassObbligatorio #nogreenpass #dittaturadraghi
3	No Vaccination Omicron	No vax with a focus on the omicron variant	#omicron #sileni #fajese, #booster, #pfizer, #omicronvirus, #arcuri, #conte, #primule, #omicronvariant, #sarccov2, #salute, #immunity, #bivacs, #dosi, #variante	#coronavirus quante #dosi di #vaccino per la nuova variante #omicron? La quarta? La quinta? #Booster? Quanti soldi contate...
4	Vaccine dose	No vax with a general focus on vaccine doses	#terzadose, #vaccini, #quartadose, #pfizergate, #supercringeppass, #vaccine, #acthunninggreenpass, #novaccinepassportsanywhere, #corteinovax, #sivax	Mi sa che farò prima la quarta e poi la prima la farò per ultima anche se vorrei farla tra la terza e la seconda #terzadose #Pfizergate #ioStoConStefanoPuzzifer #NoGreenPassObbligatorio #NoObbligoVaccinale #NoGreenPass
5	No greenpass	No vax against green pass	#greenpass, #supergreenpass, #dittatura, #dittaturasanitaria, #megagreenpass, #tamponevati_e_basta, #approvato, #decreto, #estensione, #maloreimprompviso, #novaccinoobbligatorio, #nobooter, #novaxpassports	No #supergreenpass è un'ipotesi idiota da chi ha il cervello che nemmeno il porco se lo mangia #NoGreenPass #DittaturaSanitaria #governodeipeggiori No #ObbligoVaccinale
6	No Right-Wing Vaccine	No vax with a focus on right parties	#lockdown, #vaccino, #obbligovaccinale, #larachetirala7, #borgonovo, #bastadittatura, #yonomevacuno, #apartheidvaccinale, #novaccinepassports, #novaccineemandates, #novaccinepassportanywhere, #nocebo, #freevax, #novavax, #sileridimettiti	Ezra Pound diceva: "I politici sono i camerieri dei banchieri". Se fosse vissuto oggi avrebbe certamente corretto la frase in questo modo: "I politici sono gli infermieri della mafia farmaceutica" #nogreepass #NoGreenPassObbligatorio #Borgonovo
7	"Vivi" manifestation	Vivi groups	#vivi, #vaccinoobbligatorio, #dittaturanazisantaria, #covid, #nessunacorrelazione, #v_v, #iosononovax, #parigi, #taser,	Avevamo detto ovunque?? La verità non può essere fermata #ViVi perché liberi Lotta per libertà e diritti #DittaturaSanitaria #IoSonoNoVax
8	Dockworkers	Dockworkers	#genova, #portualidigenova, #puzzzer, #democrazia, #pordenone, #lagenteconomoinonmollamai, #travaglio, #gruber, #trieste, #daspo, #stefanopuzzzer, #montesano, #triesteresiste, #fortiora	#StefanoPuzzzer: "Non dobbiamo scioperare, bisogna pensare più in grande, dobbiamo creare una struttura parallela! Presto una manifestazione con altre nazioni potrà diventare un presidio fisso! Oggi 6/12/21 a 9MQ #NoGreenPass #NoSuperGreenPass #NoGreenPassObbligatorio #Puzzzer

9	Conservatives	Right parties conservatories	#lega, #salvinipagliaccio, #gratteri, #4quinale, #salvinifaccerzan, #papeete, #restiamoumani, #salvini, #capitone, #blocconavale, #governodeimigliori, #stoprestrizioni, #forzaitalia	@borghi_claudio Interrogazioni Parlamentari? Denunce Pubbliche? #Salvini quando si smarchera' da #Speranza ? Chi ha anticorpi non si Deve Vaccinare Mai! Lo facciamo presente a quegli incompetenti del #Cts? #NoGreenPassObbligatorio La Lega continua a supportare questo #governodeipeggiori ?
10	Children vaccination	No vax against Children vaccination	#noobbligovaccinale, #bambini, #novaccini, #lobotomizzati, #noapartheidvaccinale, #loschifototale, #gramellini, #preside	#vaccini Le percentuali di contagio #Covid dei #bambini sono infinitesimali, ancor meno quelle di #mortalità .. ma la #Pfizer ha deciso che è ora di inoculare gli innocenti !! E la #dittaturasanitaria ha predisposto già i #media per la nuova tappa
11	Freedom	groups that fight for freedom	#libertà, #democraziavirale, #demagogiasolidale, #ivermectina, #idrossiclorochina, #discriminazioni, #noncedete	Il popolo torinese unito per la #RESISTENZA #NoGreenPass no #DittaturaSanitaria no #vaccinoobbligatorio w la #Liberta
12	Others	We were able to identify other community but they were not connected to the no vax speech	-	-

**Figure 67.** Nov/Dec communities

In this table we find the communities about the period of November-December 2021. The first community, called *Right Wing media*, is composed by the hashtags related to the right wing media and, as we can see from the the tweet example, no-vax communities wrote comments quoting a lot from these journalists. The *Draghi's administration* community is the second one. In this we can find no-vax who protest against the government and especially against the sanitary measures that were taken. Actually the main hashtags are #draghingalera (Draghi to jail), #draghistan, #ipocondriaci(hypochondriacs). The third community is about the vaccination but with a focus on the Omicron variant of COVID-19, that took hold at the times. Since the symptoms got milder, many no vax complained about the Green Pass restrictions. On the other hand the fourth community is made by people who complained about the number of doses, since when the vaccination campaign started the number of doses needed was not clear also for the experts. With times the amount of required doses to gain the Green Pass augmented and no-vax complained about it. The fifth community is called *no green pass*, and as for the previous networks it is focused on the Green Pass, putting the accent on the fact that as the number of doses required to obtain certification increased, journalists began to employ names such as "#supergreenpass". *No Right-Wing Vaccine* is a community that complains about the vaccination but with a focus on the right wing

Figure 68. Nov/Dec net

**Figure 69.** Nov/Dec

and one of the most relevant nodes is Francesco Borgonovo, a famous right-wing journalist. The seventh is about "vivi", a group of no-vax protesters that became famous during this period. This time the dockworkers protest are captured by only one community. The reason is that at the time these protests were fading. The ninth community is about the *conservatory party*, with a specific focus on Lega as in the period of the vaccination campaign. The opinions of the no-vaccines about the Lega party did not change. The tenth is about the *children vaccination* since in the public debate the hypothesis that also children would have needed the Green Pass (and consequently the vaccine) started to emerge, hence the complain of no-vax groups. Last community is still about *Freedom*, as already seen in the previous network.

6.1.4. Other Gephi plots (Prevax and 2022)

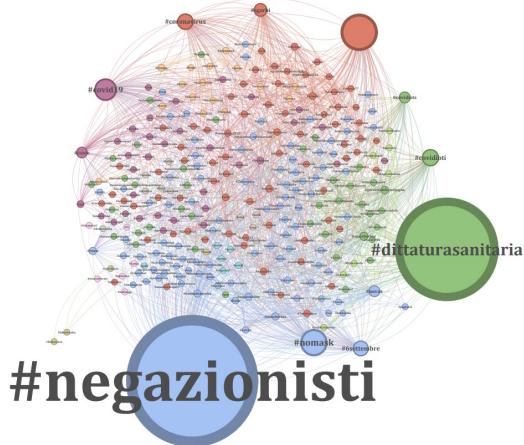


Figure 70. Pre-Vax

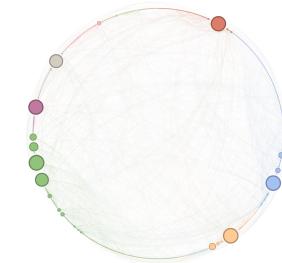


Figure 71. Pre-Vax net

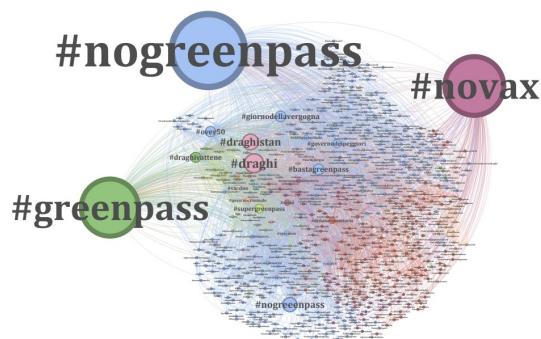


Figure 72. 2022

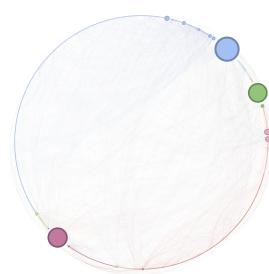


Figure 73. 2022 net

7. LIWC results

It is known that human beings are distinguished by the peculiarity of 'living socially', that it means belonging to groups. Individuals choose and evaluate their being together with others on the basis of various reasons. Mainly they do so for the advantages this brings (in terms of gratification, enjoyment, mutual help...) and for the costs required (willingness and questioning or being questioned, receiving sometimes confusing messages from those around, being hurt or injured...). The dynamics that govern our being around others are numerous and complex. This also occurs in social media. Our focus is on the social interaction of the Novax communities on Twitter, the main topics discussed on it and consequently the messages that generated the most social interaction.

7.1. Health

In this plots the values related to health dictionary were low. In fact the text of the tweets concerned about: restriction, dictatorial regime etc.. and not about health words.

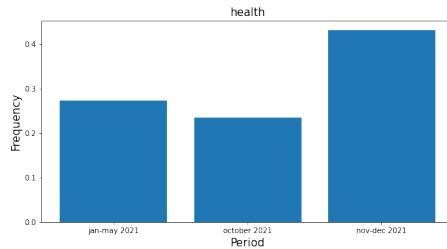


Figure 74. Health

7.2. Social

Firstly, the reference period needs to be put into context. Considering a time frame starting in October, the dockworkers' communities (particularly the one of Trieste and then the one of Genova) had the most social concerns over the green pass issue. The government induced new rules in which workers had to possess the green pass (and therefore all the necessary vaccine doses) to access the workplace. These people, upset by the government's decision, led to numerous protests. The dockers threatened a total shutdown of their activities, resulting in millions of euros being lost to the Italian economy. The graphs illustrate perfectly what happened during this period.

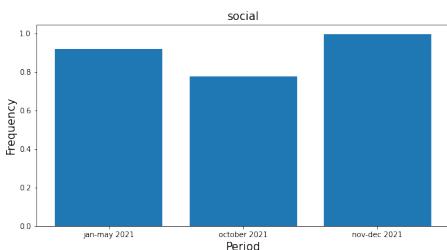
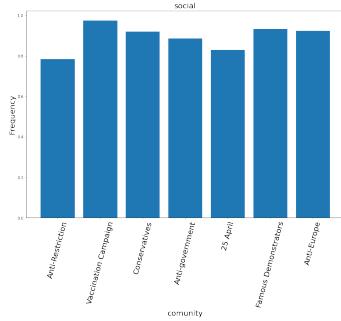
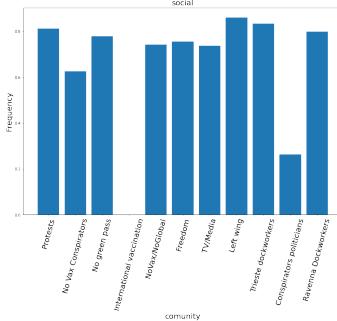
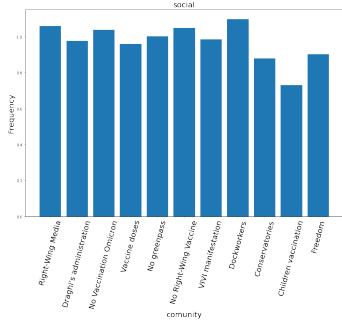


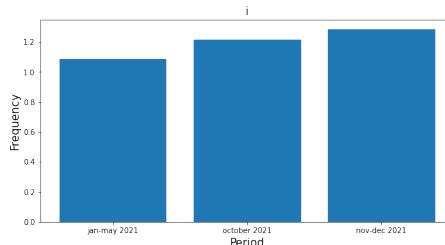
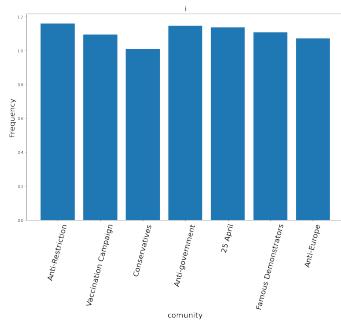
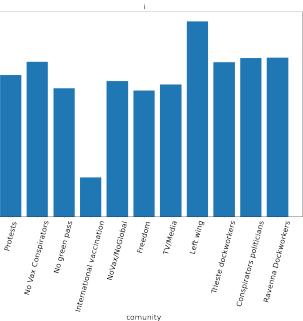
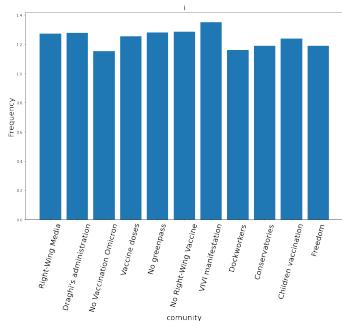
Figure 75. figure
Social

**Figure 76.** Vaxcamp**Figure 77.** October**Figure 78.** Nov/Dec

As we can observe, in the third network there was a lot of social interaction between the no vax people as they had a lot to talk about and discuss. In fact, one can see by looking at the graphs that the network with the highest peak is the third one (with value of 1), which corresponds to November and December 2021. The Novax communities with the highest peak are those dealing with dockworkers (hence workers without green pass), protests, and negative sentiments against the government. This is because the right wing was against the green pass, more specifically against the restrictions it implied, decided by the party that was in government at the time. After that, the right wing had to adapt to the green pass rules by the Draghi government. Despite the disagreement with the government, Matteo Salvini of the LEGA party made somewhat confusing statements in order to keep a high number of voters. For this reason, right-wing voters often showed their disagreement with this stance through tweets. This is the reason why we can notice that there are picks in the communities of “right-wing media”, “Novax right wing” (about the value of 1).

7.3. Pronouns

Pronouns are of crucial importance because they reveal how an individual refers to those who are part of the interaction and those who are not. In the Italian language, subject pronouns are often omitted because they are not essential for the rules of syntax. This is a significant difference to other languages such as English and German. This is why LIWC has difficulty calculating values in numerical terms. Despite this, it was possible to evaluate and analyse the graphs.

**Figure 79.** Pronouns**Figure 80.** Vaxcamp**Figure 81.** October**Figure 82.** Nov/Dec

It emerged that participants used more first-person singular pronouns and fewer other pronouns, such as third-person singular pronouns (e.g. 'he', 'she') when describing an event in which they felt they were being made fun of or when they expressed their opposition to government decisions. In fact, the community that used a higher number of 'I' pronouns corresponds to the 'left wing'. This community belongs to the second network, although the highest average value is found in the third network. This network corresponds to the period of November and December 2021, in which the Novax people, tired of the solutions adopted by the government, expressed their dissent regarding Draghi government (about 1,2). Another relevant value is that of the 'Vivi' manifestation (about 1,4). In all these cases, one can see how the focus is on the person being mocked, the victim of the event. The Novax communities put themselves, their thoughts, their negative emotions about the solutions adopted by the government at the centre.

7.4. Verbs

We can therefore understand from this analysis that "Basic grammatical categories may carry social meanings irrespective of their semantic content". (Tausczik YR, Pennebaker JW. The psychological meaning of words: LIWC and computerized text analysis methods. *Journal of Language and Social Psychology* 2010;29(1):24-54.)

Verbs are markers of agency. Agency is a fundamental concept of socio-cognitive theory, which has Albert Bandura as its main exponent. Human agency (human agency) can be defined as the capacity to act intentionally in the social context in which one operates in order to generate change, regardless of the outcome of the action. It concerns both individuals and groups, and is expressed in the ability to generate actions directed towards certain goals and/or objectives; fundamental to the quality of performance is the sense of self-efficacy, i.e. the conviction of being able to actively exert an influence on events. Verbs appear more often in association to agentic social targets (male, young etc.) In fact, by observing the graphs we can notice that the communities which use more verbs the most are those that have to do with protests, riots and negative sentiments against the government. In fact, there is a peak of 2.5 in the community of student protests. This community belongs to the second network, which is the period of October 2021. This period, in fact, is remembered as a period of protests against the greenpass and more and more restrictions occurred because of it and the vaccine doses. These are the most popular hashtags: # liberta, # nonaupasssanitaire, # liberascelta, # studenticontroilgreenpass, # italyprotest, # lavoro, # manifestation23october, # diritti, # manifestazionenogreenpass, # triesteresiste, # novacinepassportsanywhere, # manifs16ottobre, # freedompass, # vita, # amore, # bloccostudentesco.

While personal pronouns provide information on the subject of attention, the tense analysis of common verbs can tell us what the temporal focus of attention is.

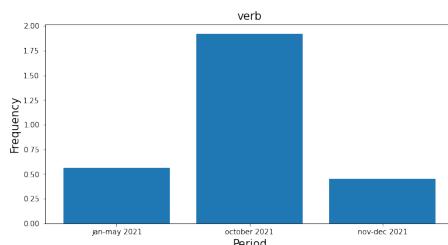
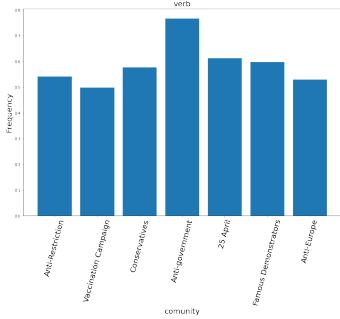
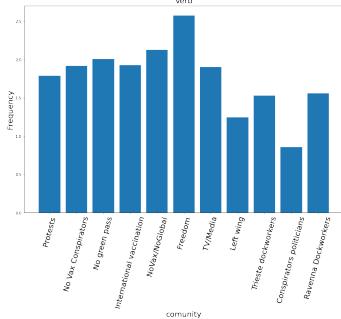
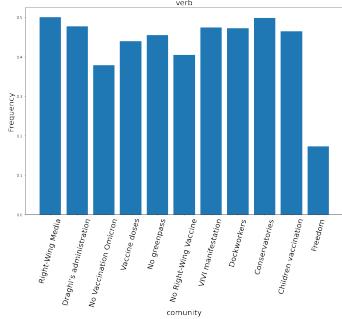
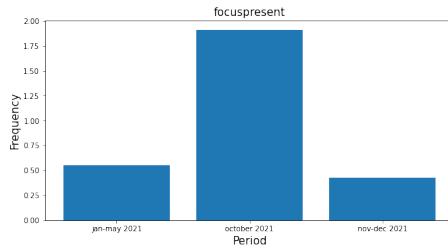
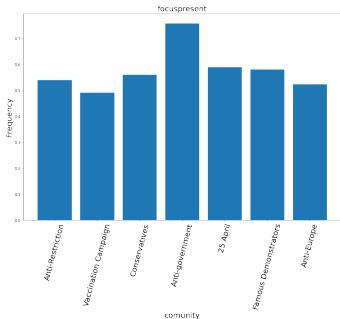
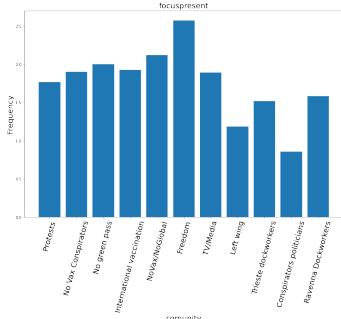
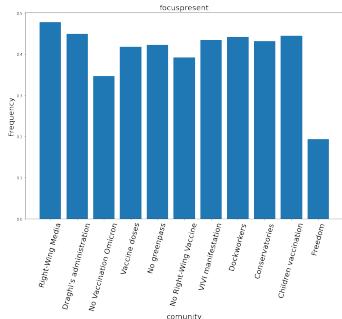


Figure 83. Verbs

**Figure 84.** Vaxcamp**Figure 85.** October**Figure 86.** Nov/Dec

7.5. Focus Present

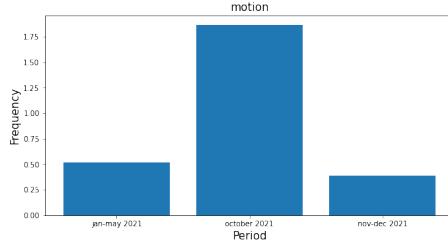
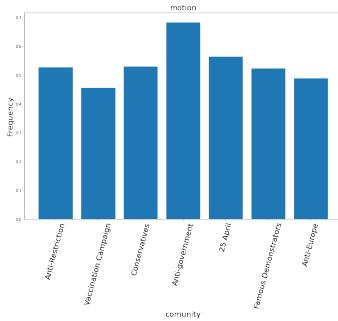
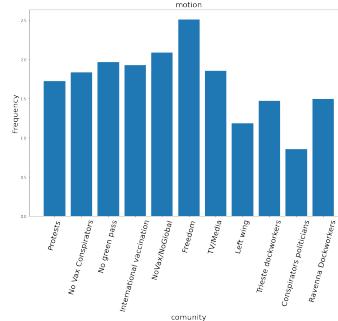
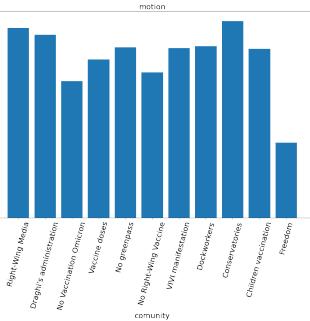
The time orientation also gives us a deeper understanding of how people are processing a situation or event.

**Figure 87.** Focus Present**Figure 88.** Vaxcamp**Figure 89.** October**Figure 90.** Nov/Dec

As we can observe from the graph, the Novax communities in October 2021 seem to be more focused in the present time than in the other periods. The highest peak of 2.5 in the second network, which corresponds more precisely to the student protest community. The tendency to think in the present was associated with the Novax' interest in the issues of that time: the compulsory green pass and the vaccination doses that were required to carry out everyday activities. The Novax were therefore not interested in the future. Present tense verbs are used more in the second network (more precisely in the community "student protests") to incite participation in demonstrations against the green pass. Verbs in the present imperative are used a lot in order to incite attendance thus creating a greater sense of unity and group strength.

7.6. Motion

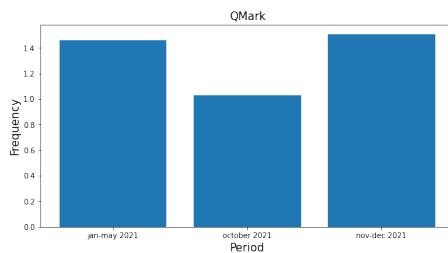
We can also notice that the focus present is very similar to the histogram of 'motion'.

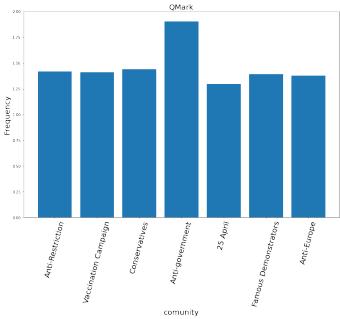
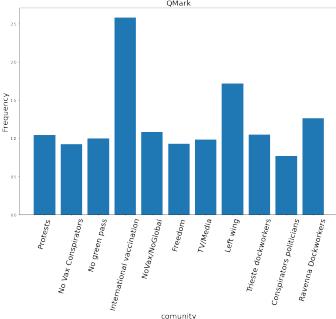
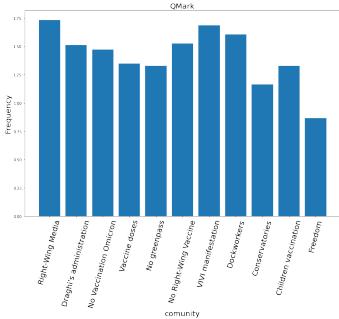
**Figure 91.** Motion**Figure 92.** Vaxcamp**Figure 93.** October**Figure 94.** Nov/Dec

We analysed the 'motion' dictionary, which corresponds to the use of motion words (e.g. go, arrive, car). Movement is one of the indicators of an individual's degree of processing of the scenario description. The second network shows that more movement words and verbs were used during this period than in the other two networks. It was considered that the increased use of movement words was due to the fact that many protests and manifestations against the vaccine campaign and the vaccine itself took place during the October period. In fact, the community that used the most movement words was the student protests with a frequency of 2.5.

7.7. Question Marks

We also analysed the presence of question marks in the Novax tweets. Generally question marks show how individuals are responding to each other. They are also often a way to get other people's opinions, to find support or to remove doubts about particular issues. By analysing the tweets we have noticed that the use of the question mark is usually meant in an insolent and sarcastic manner and often are rhetorical questions, mockery of vaccinations and government-induced restrictions. This is a way of stating the opposite of what one thinks with the aim of ridiculing or emphasising concepts to provoke laughter and often with contempt. This is a typical Italian way of being ironic in society or in a group.

**Figure 95.** Question Marks

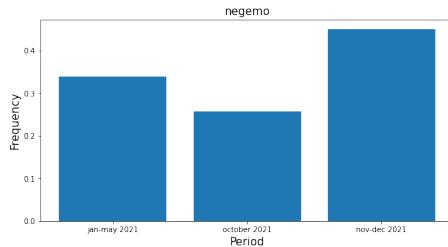
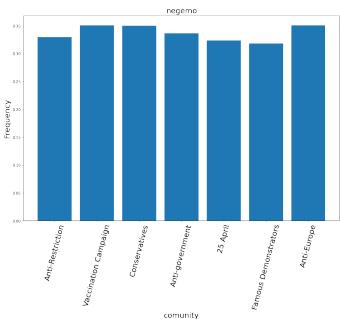
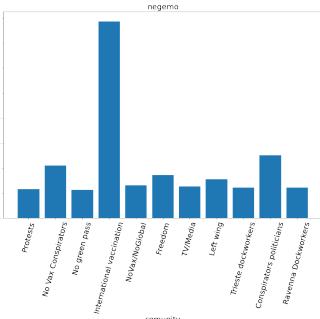
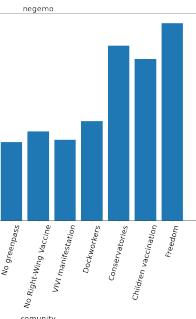
**Figure 96.** Vaxcamp**Figure 97.** October**Figure 98.** Nov/Dec

To give one example: Mattarella siamo grati a chi ci ha lasciato un paese libero e democratico" e quale sarebbe visto che avete distrutto la democrazia???? #NoGreenPassObbligatorio #dittatura

The third network has a higher question mark frequency close to 1.5 thanks to the communities (in descending order) 'right-wing media', 'Vivi' manifestation' and 'Genova dockworkers'. At the same time, the frequency in the first network does not stray very far from the third being just over 1.4 mainly due to the 'anti-state' community Meanwhile the frequency of question marks in the second network is significantly smaller than the other two and is around 1.0.

7.8. Negative Emotion

Looking at the graphs, it appears that the highest average peak of negative emotions corresponds to the third network, i.e. the period November-December 2021 (about 0.4). This happens even though the highest peak occurs in the second network, which corresponds to the period of October 2021. The peak is 1.5 and concerns international vaccination.

**Figure 99.** Negative Emotion**Figure 100.** Vaxcamp**Figure 101.** October**Figure 102.** Nov/Dec

In other words, negative emotions have increased in communities and have become stronger as time and the pandemic, restrictions and the compulsory green pass have increased. The motivation lies in the fact that Novax communities (not having the required vaccine doses) could not carry out their activities, work and leisure, freely. In fact, the community with the highest peak in the third network corresponds precisely to that of "freedom", and the other relevant communities in this network are related to vaccines (especially "children vaccination") and the world of politics (the

“conservatories” community). One can understand that the main negative emotions are therefore connected to feelings of disagreement rather than fear.

8. Conclusion

With this project we tried to capture the evolution through the time of the No vax speech on Twitter. In order to do it we built 5 different networks, which represent different periods:

- i March 2020-September 2020
- ii January 2021 - May 2021
- iii October 2021
- iv November 2021 - December 2021
- v February 2022 - May 2022.

For each period we download the hashtags from Twitter using the same queries. We found that they were free scale networks and disassortative. We were able to capture communities related to the no-vax speech only in the second, third and fourth networks. This is due to the fact that in the first period the discussion about the vaccine were not started, since the vaccine came out only from the second period onwards. In the last period the vaccination topic was not so crucial and it was spread in other topics. For this reason it was not possible to find a good community stricture, in fact the modularity for this period was very low (0.222). In the middle periods we detected different communities related to the no-vax speech. For each network the nuances of the speeches (such as protest, restriction anti "regime", etc..) has been investigated, along with their time evolution.

For the semantic analysis, thanks to LIWC's insights, we found the differences among the periods and the communities. All the three periods have a special focus on the present since no-vax people were concerned about the period they were living rather than the past or the future. Surprisingly the words contained in health dictionaries were not much used, since the no-vax were more focused on criticizing the political establishment and their decisions. Moreover no-vax communities were mainly focused on present and the use of "motion" words is due to the protests and manifestations against the vaccine campaign. Then we noticed that the use of question mark is usually to be intended in an insolent and sarcastic key.

Thanks to this project we reflect on how social media, but more in general media (also the traditional ones) influence the public debate and the behaviour of our society. It has become apparent that individuals often reinforce their biases on social media platforms, leading to a lack of diverse perspectives and healthy discussions. Our findings indicate that within the communities studied, there was a lack of meaningful debate and instead a segment of the Italian population resorted to expressing their opinions vociferously through online communication.

References

- [1] Limaye RJ, Holroyd TA, Blunt M, Jamison AF, Sauer M, Weeks R, Wahl B, Christensen K, Smith C, Minchin J, Gellin B. Social media strategies to affect vaccine acceptance: a systematic literature review. *Expert Rev Vaccines.* 2021 Aug;20(8):959-973. doi: 10.1080/14760584.2021.1949292. Epub 2021 Jun 30. PMID: 34192985.
- [2] Ortiz-Sánchez E, Velando-Soriano A, Pradas-Hernández L, Vargas-Román K, Gómez-Urquiza JL, Cañas-De la Fuente GA, Albendín-García L. Analysis of the Anti-Vaccine Movement in Social Networks: A Systematic Review. *Int J Environ Res Public Health.* 2020 Jul 27;17(15):5394. doi: 10.3390/ijerph17155394. PMID: 32727024; PMCID: PMC7432886.
- [3] Herrera-Peco I, Jiménez-Gómez B, Romero Magdalena CS, Deudero JJ, García-Puente M, Benítez De Gracia E, Ruiz Núñez C. Antivaccine Movement and COVID-19 Negationism: A Content Analysis of Spanish-Written Messages on Twitter. *Vaccines (Basel).* 2021 Jun 15;9(6):656. doi: 10.3390/vaccines9060656. PMID: 34203946; PMCID: PMC8232574.
- [5] Chiou, Lesley and Tucker, Catherine, "Fake News and Advertising on Social Media: A Study of the Anti-Vaccination Movement", National Bureau of Economic Research, Working Paper Series 25223, 2018 Nov. doi = 10.3386/w25223, URL = "<http://www.nber.org/papers/w25223>"
- [6] Cascini F, Pantovic A, Al-Ajlouni YA, Failla G, Puleo V, Melnyk A, Lontano A, Ricciardi W. Social media and attitudes towards a COVID-19 vaccination: A systematic review of the literature. *EClinicalMedicine.* 2022 Jun;48:101454. doi: 10.1016/j.eclinm.2022.101454. Epub 2022 May 20. PMID: 35611343; PMCID: PMC9120591.
- [7] Tausczik, Yla Pennebaker, James. (2010). The Psychological Meaning of Words: LIWC and Computerized Text Analysis Methods. *Journal of Language and Social Psychology.* 29. 24-54. 10.1177/0261927X09351676.