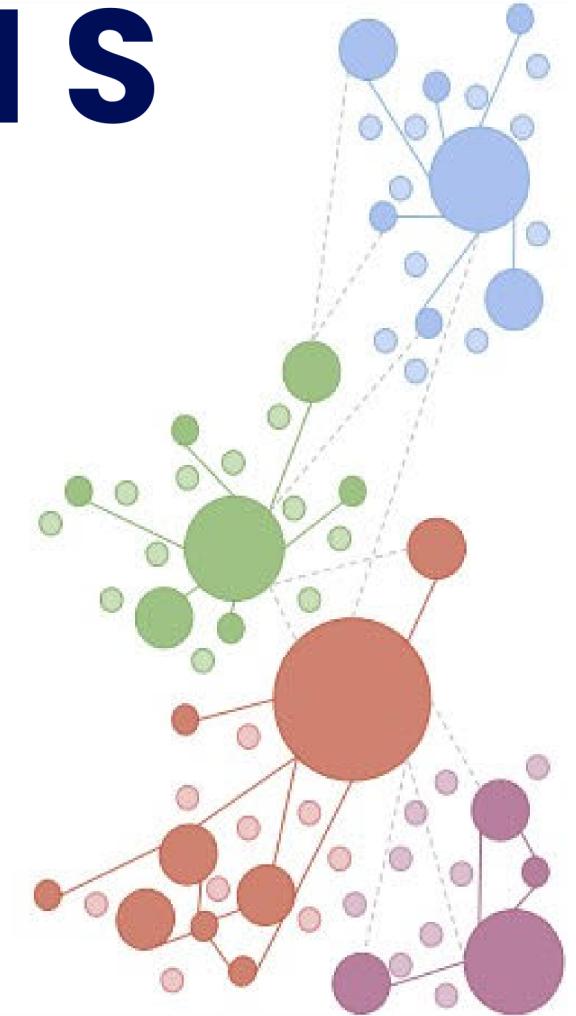


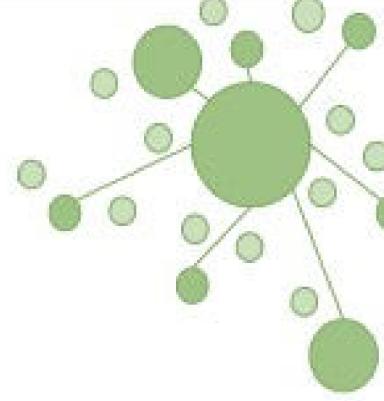
NETWORK SCIENCE

&

SOCIAL NETWORK ANALYSIS

Project group



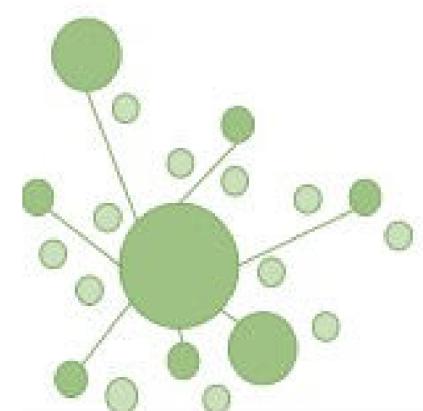


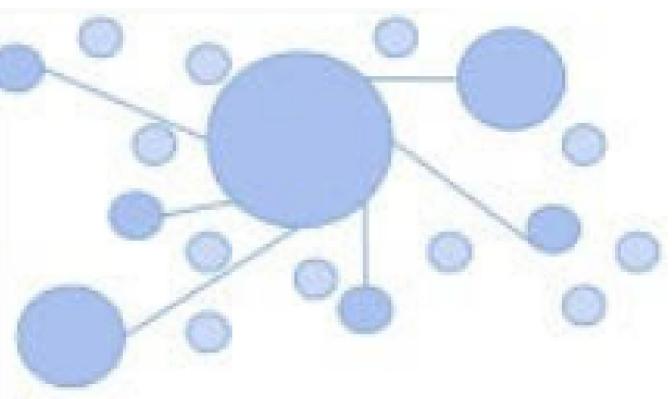
SNA group members

Giulia Pettenazzo, Laura Rettore

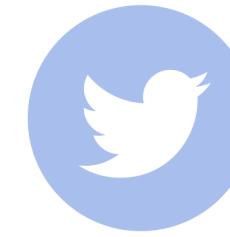
NS group members

Arash Ahmadian, Matteo Pernini,
Francesco Sartori, Pietro Sittoni

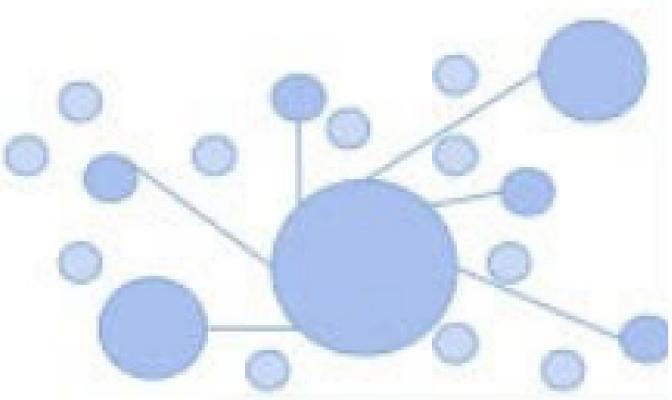


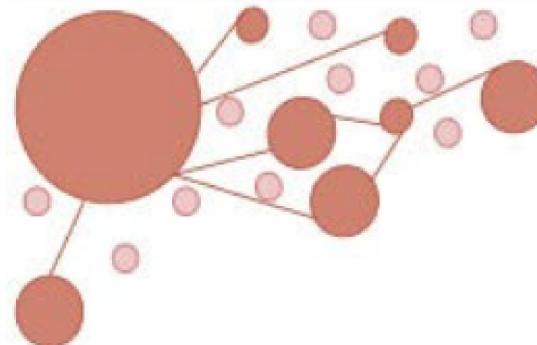


Topic



Speech on social media
about covid-19 vaccination



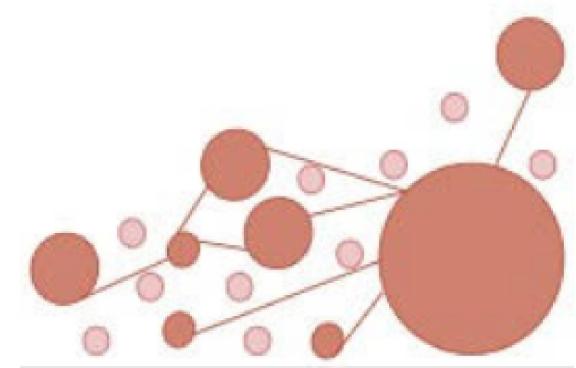


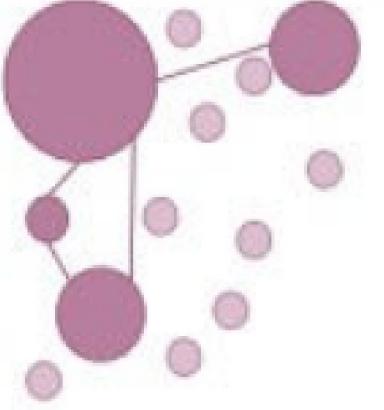
INTRODUCTION

.....◦ **PANDEMIC AND COVID VACCINE**

.....◦ **SOCIAL MEDIA AND FREE PEOPLE'S OPINIONS**

.....◦ **NOVAX GROUP**

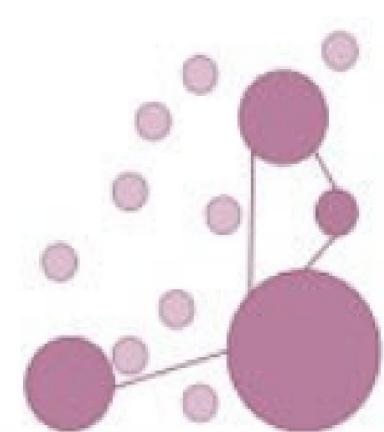


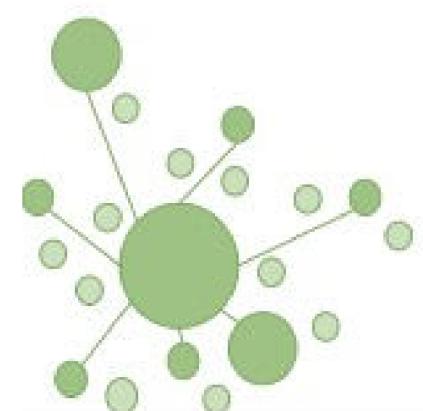
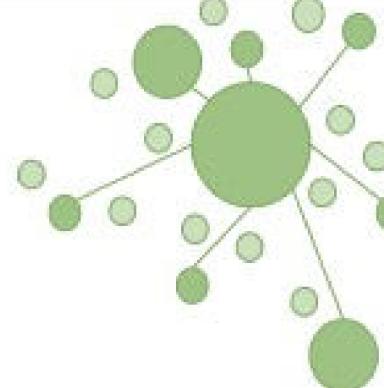


RESEARCH QUESTION



How has covid vaccination influenced
the Novax communities on Twitter?

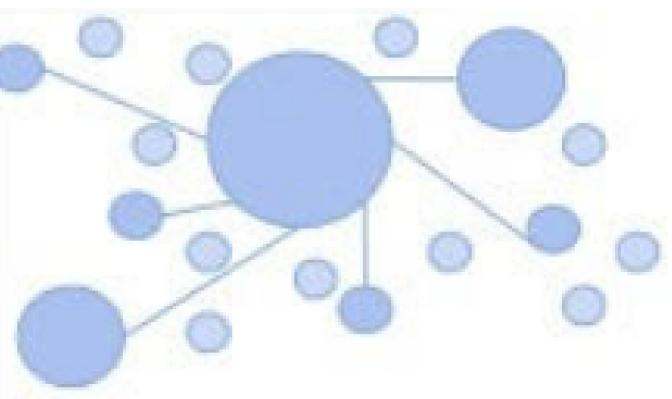




TARGET AND COUNTRIES IN EXAM

TARGET: PEOPLE USING TWITTER

LANGUAGE: ITALIAN



Network building

Query hashtags

#nogreenpassobbligatorio, #NoVaccinoObbligatorio,
#DittaturaSanitaria, #novaccinoCOVID, #nocavie,
#primule, and #ProVaccino

Five networks

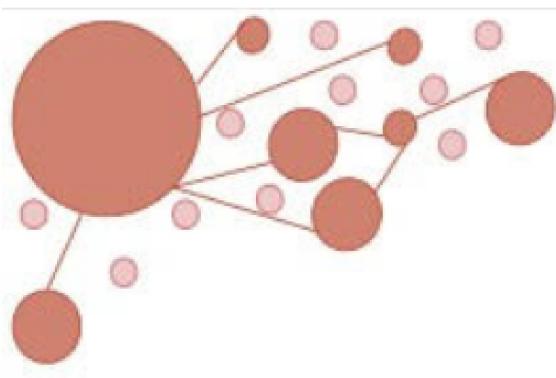
March 2020–September 2020: Pre-Vax

January 2021 – May 2021: Vaxcamp

October 2021: October

November 2021 – December 2021: Nov/Dec

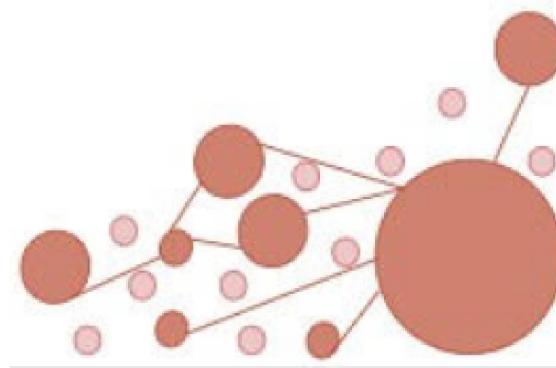
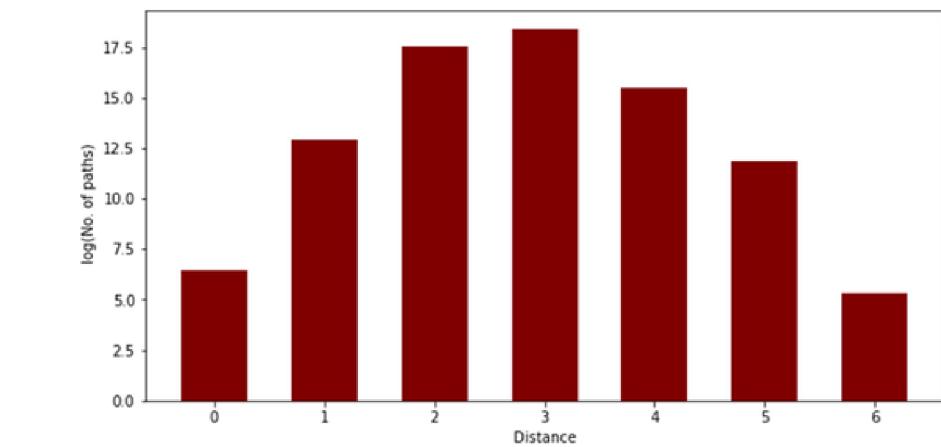
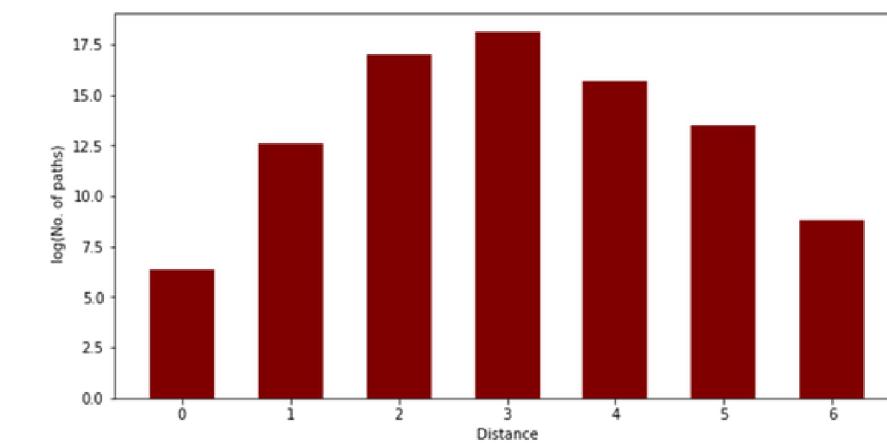
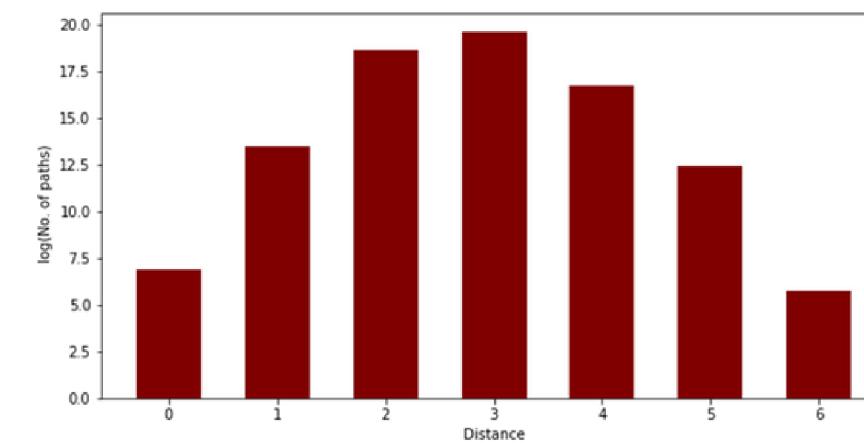
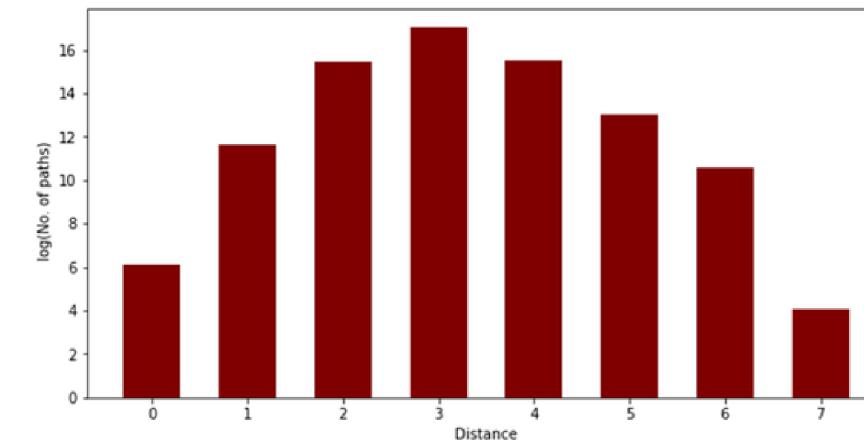
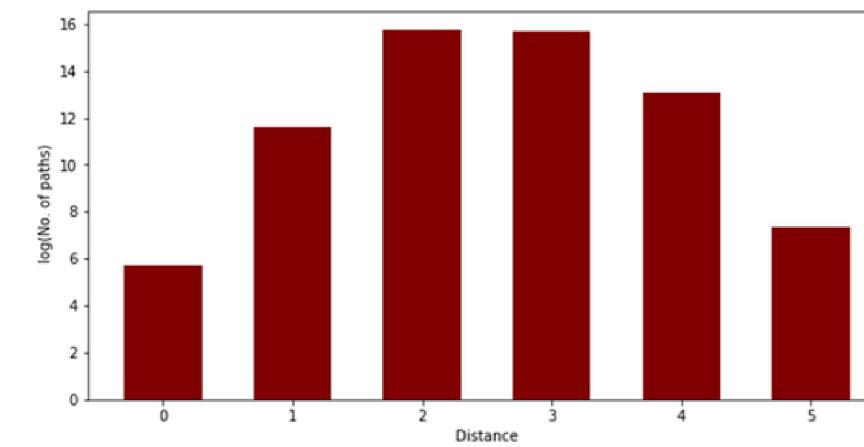
February 2022 – May 2022 : 2022

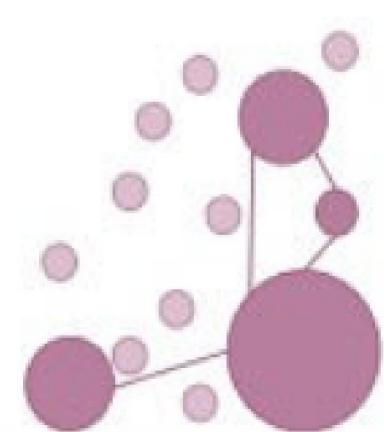
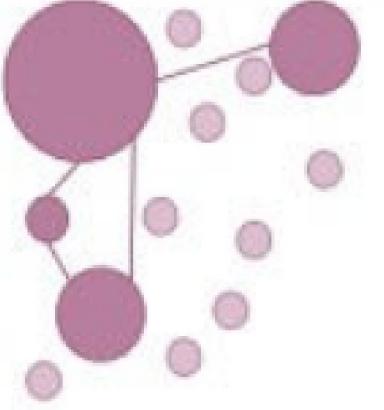


Structure of the networks

Path Length

The October network is the biggest one even if it is not the one with the highest average path length. While the smallest ones are the network of the Pre-Vax and 2022 periods.



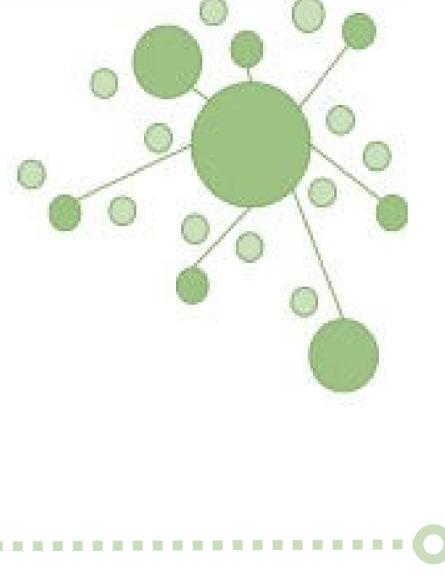


Structure of the networks

Average Path Length/Diameter

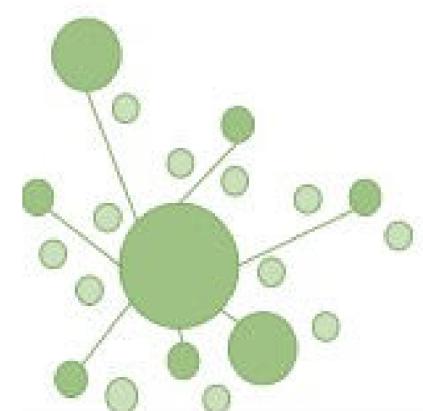
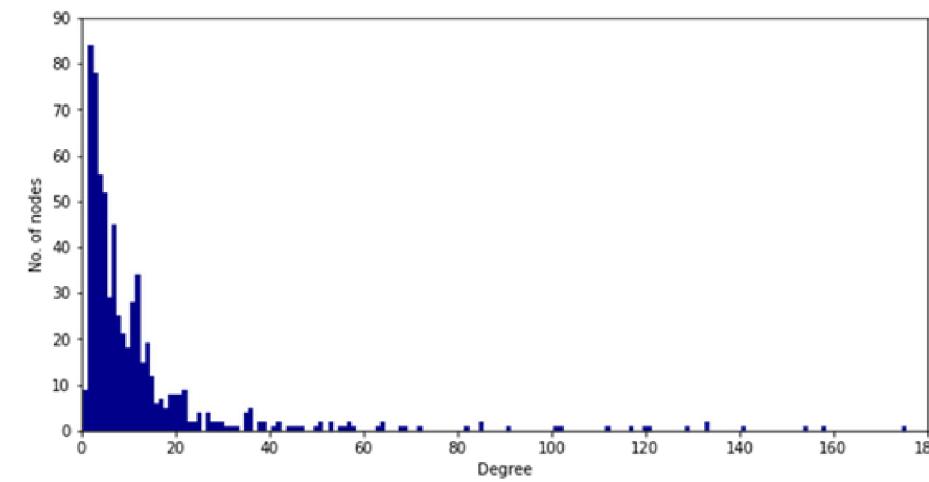
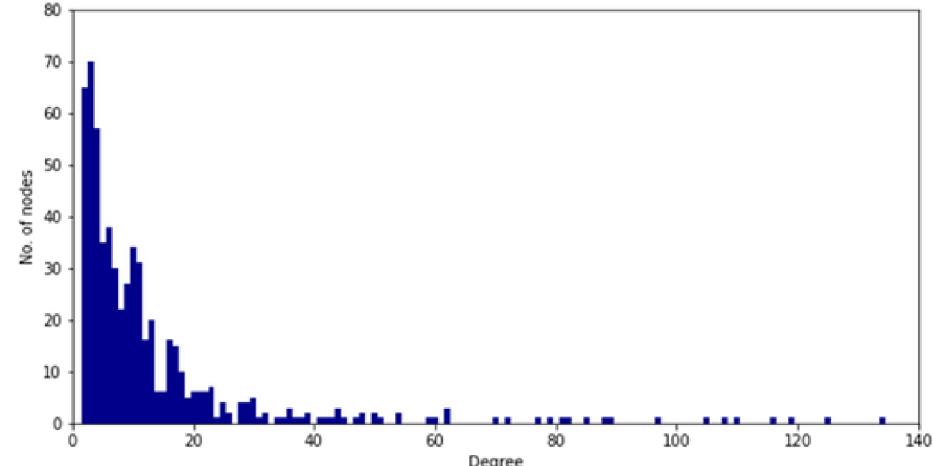
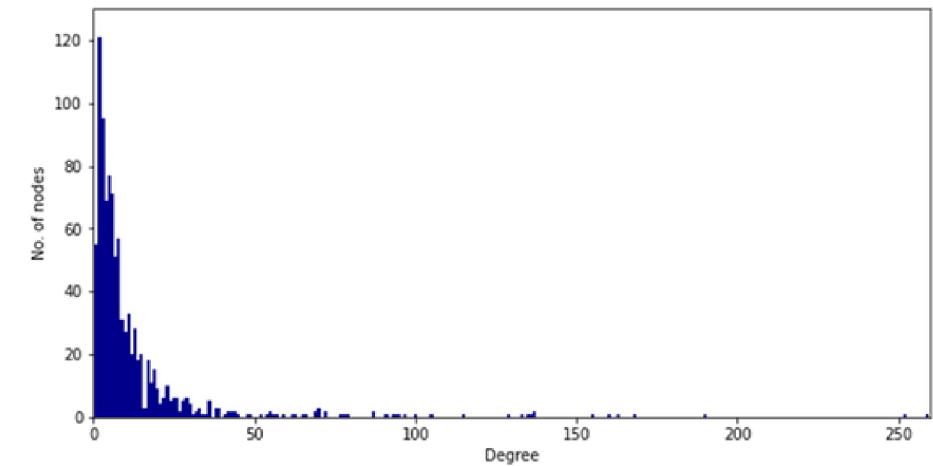
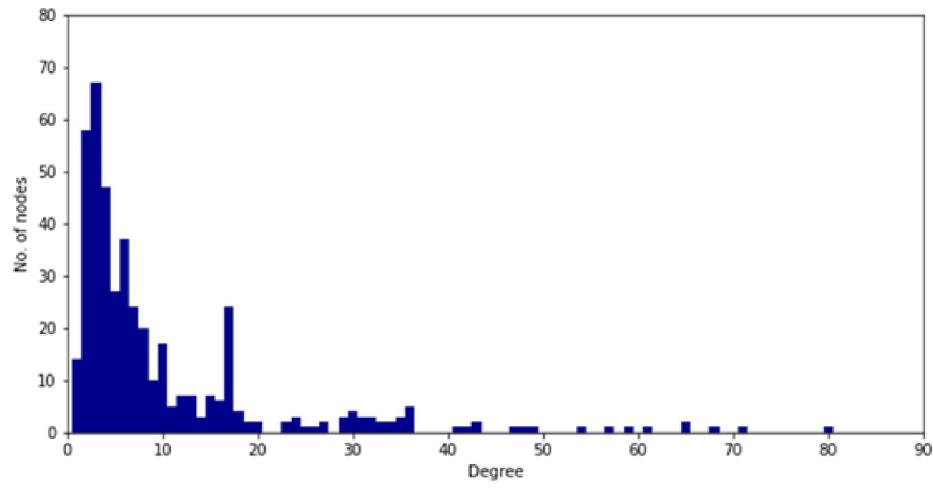
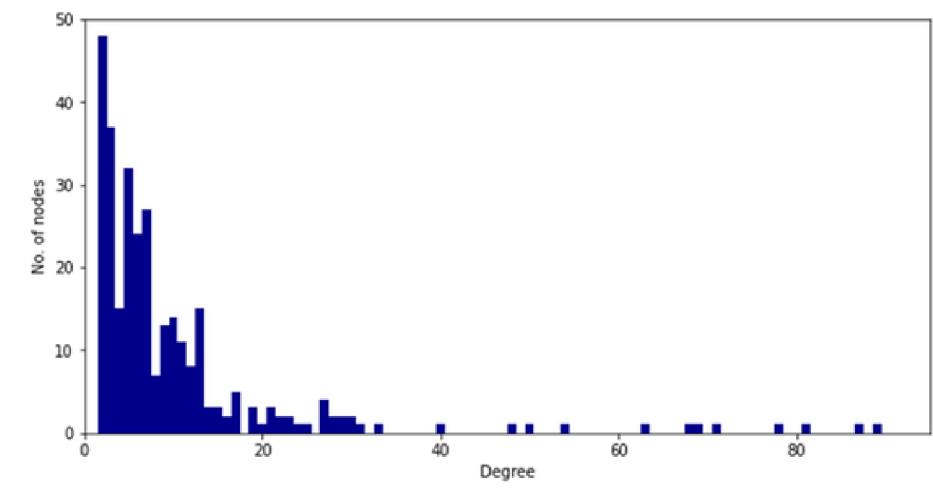
The trends are quite similar with an average path length between 2 and 3. The diameter reflects the behavior of the average path length.

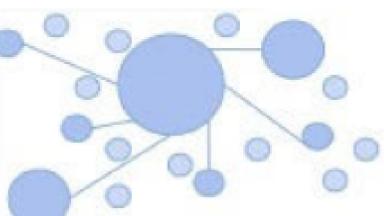
Network	Diameter	Average Path
Pre-Vax	5	2.53
Vax-Camp	7	2.90
October	6	2.74
Nov/Dic	6	2.85
2022	5	2.58



Node Degree Distribution

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.

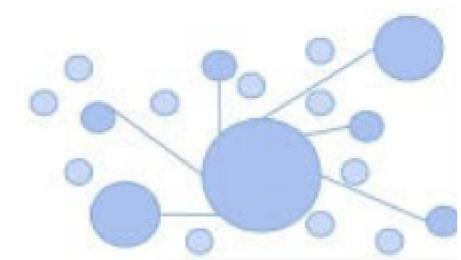
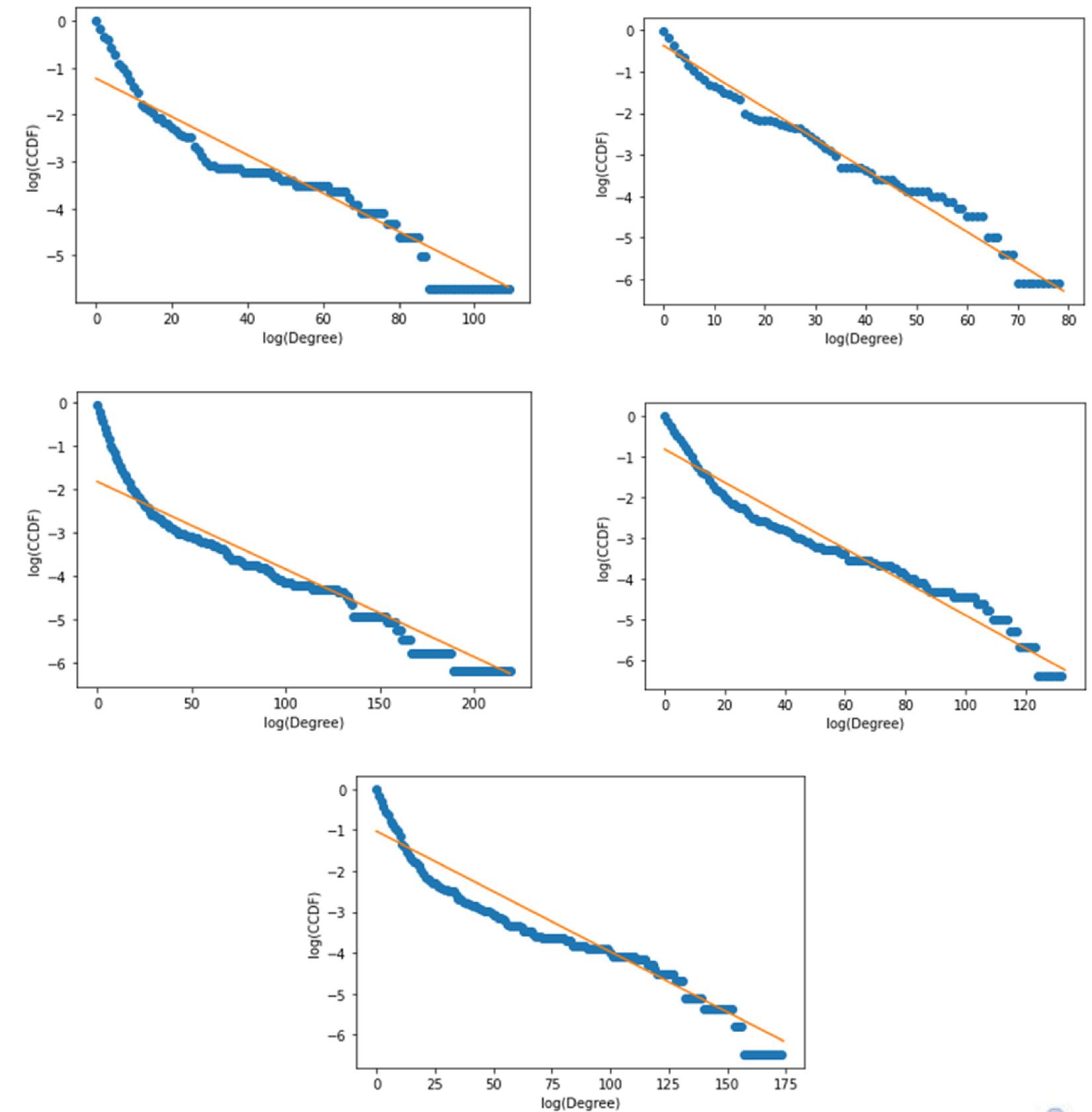


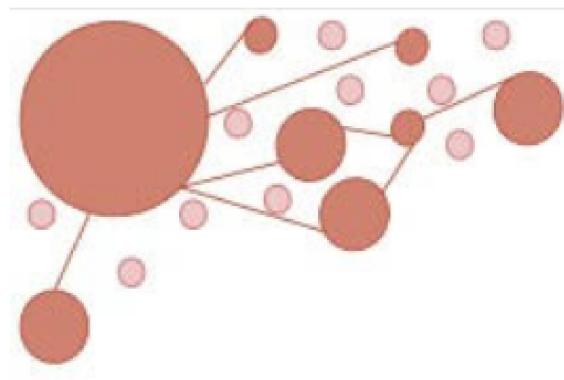


Complementary Cumulative Distribution Function

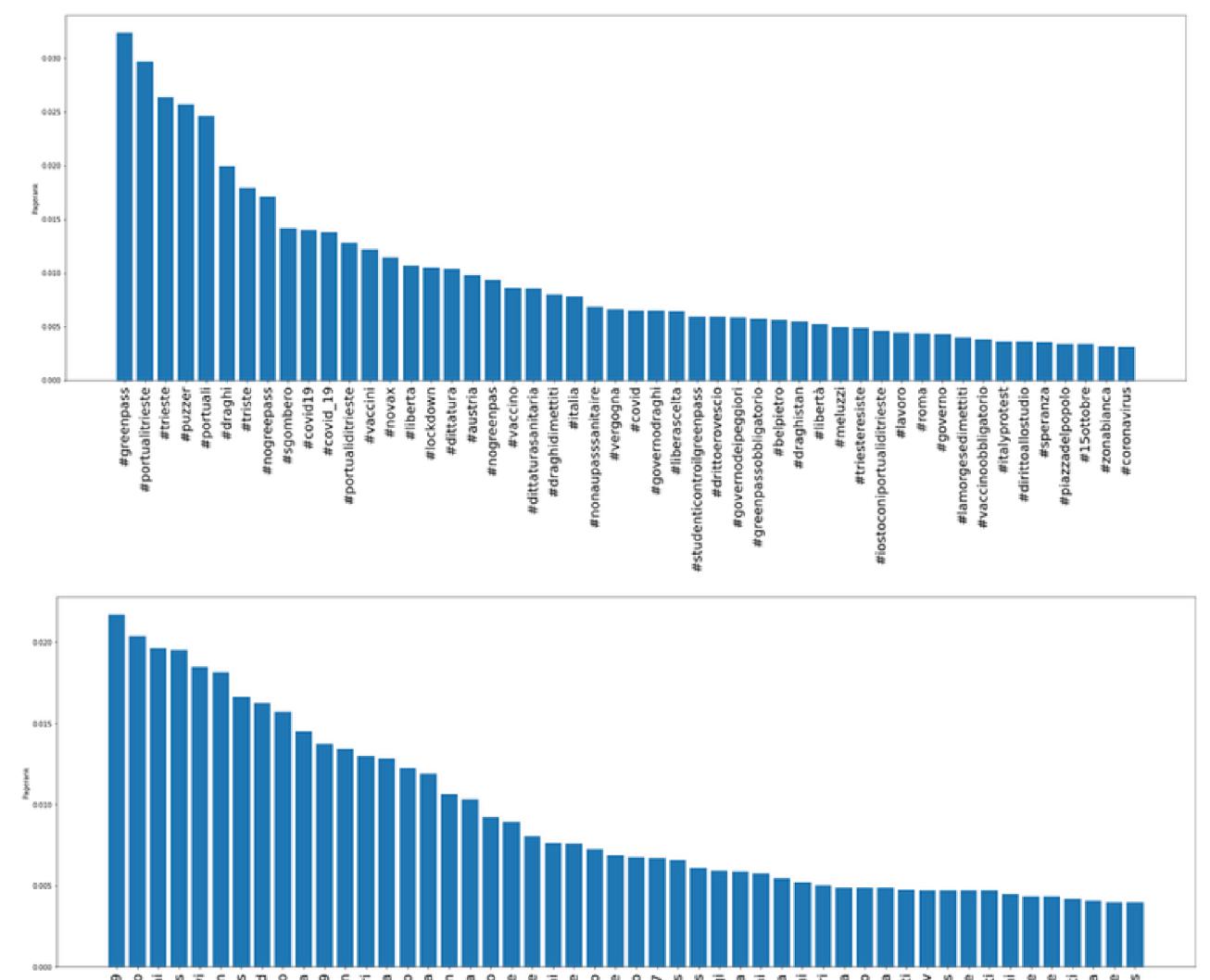
We can see that the cumulative degree distribution of the networks follows the power law. So, we can consider them as free scale networks and we can do inference.

From now on we will discuss the three most important periods: Vaccination Campaign, October and November/December



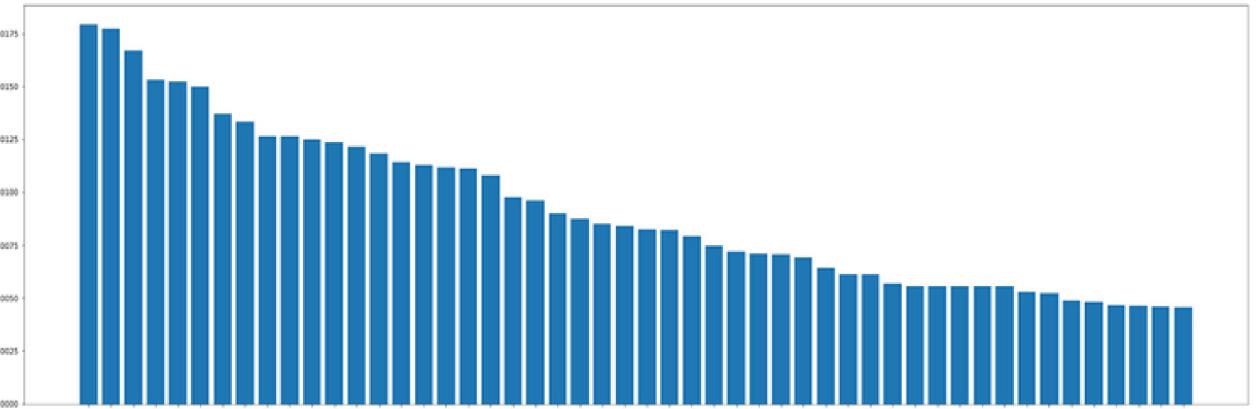


Pagerank analysis



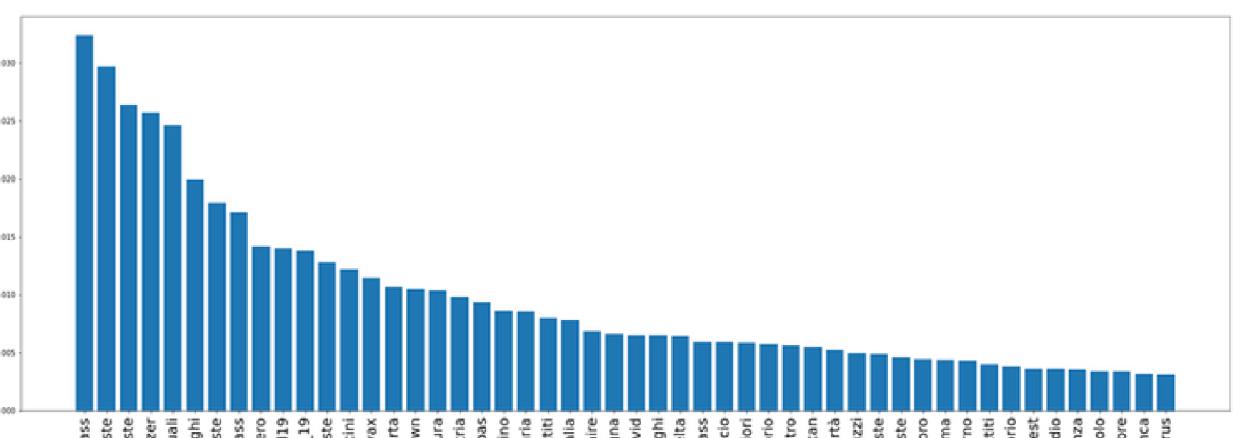
Pagerank for the period October 2021

#greenpass, #portualitrieste, #trieste, #puzzler, #portuali, #draghi



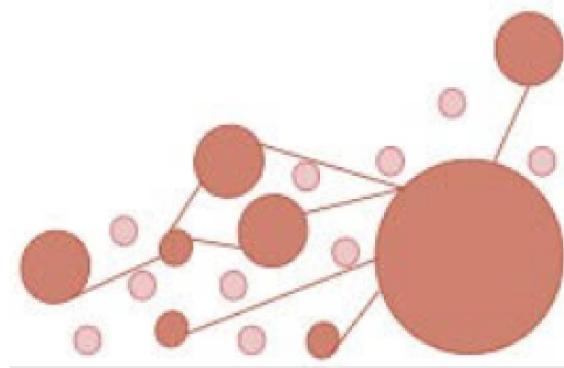
Pagerank for the period January - May 2021

#arcuri, #obbligovaccinale, #itaexit, #liberta, #costituzione, #draghi

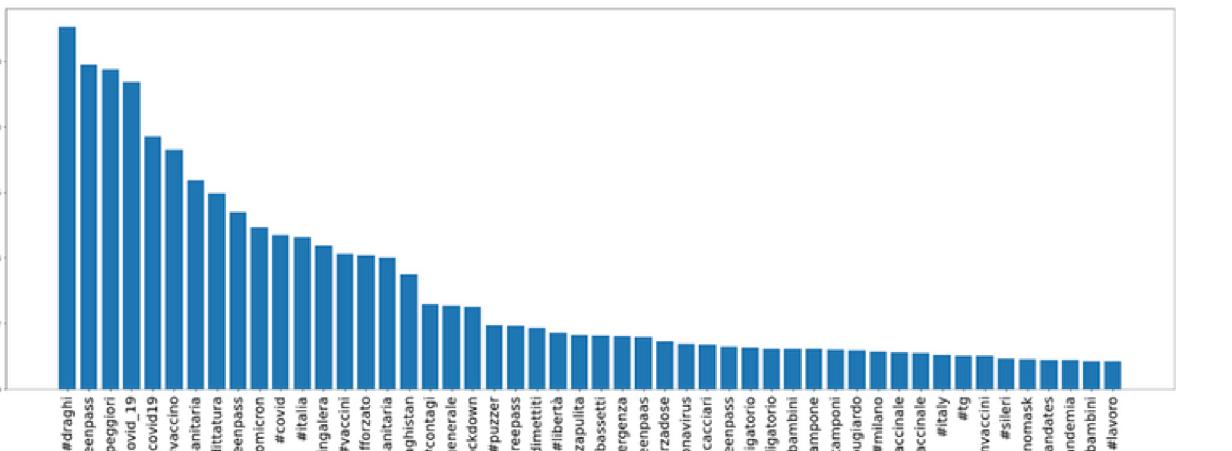
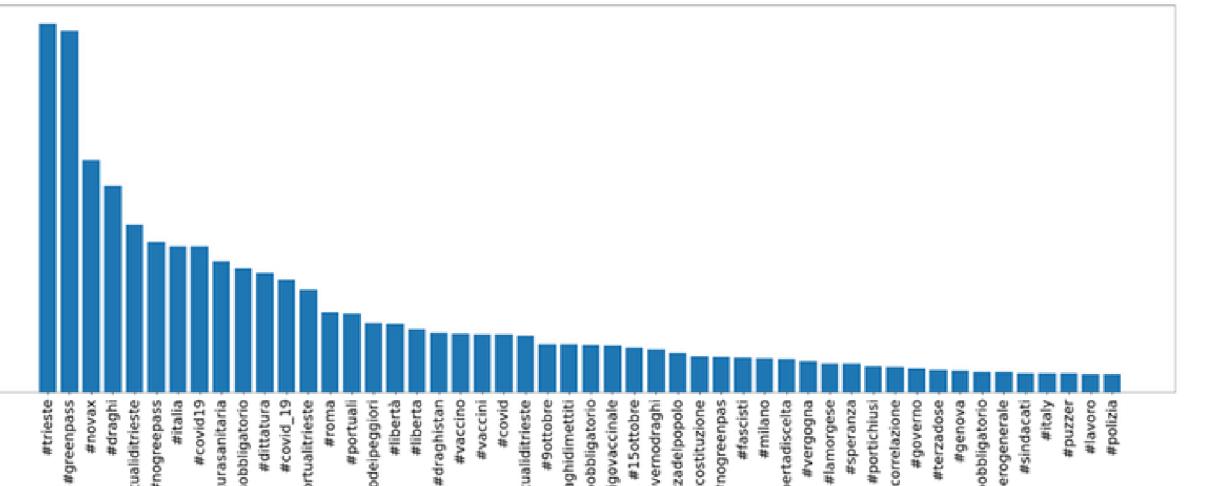
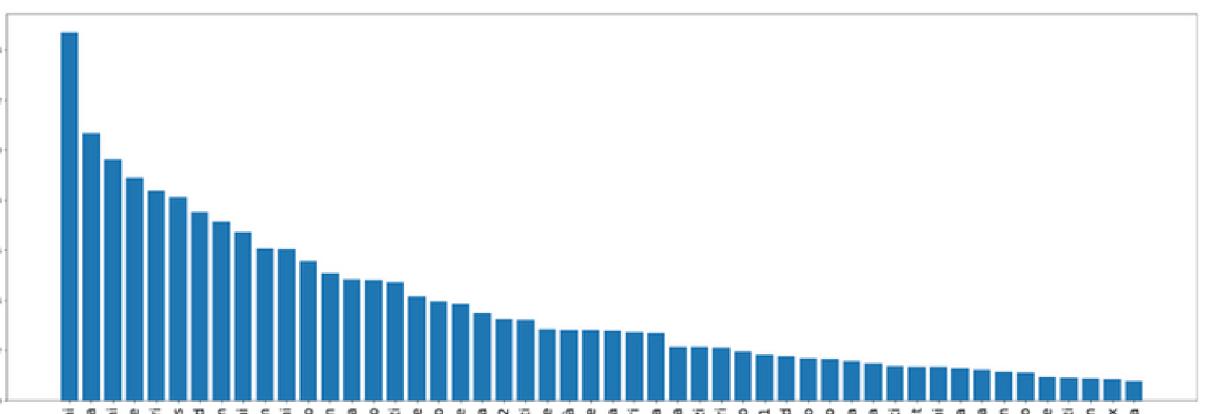


Pagerank for the period November - December 2021

#covid_19, #vaccino, #draghi, #greenpass, #vivi, #lockdown, #supergreenpass



Betweenness analysis



Betweenness for the period January - May 2021

#draghi, #terzaondata, #salvini, #conte, #arcuri, #lockdown

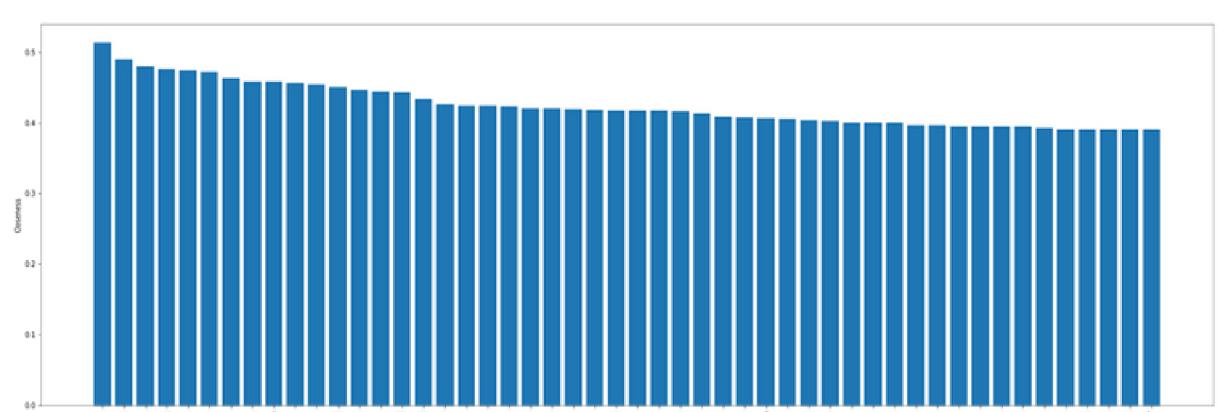
Betweenness for the period October 2021

#trieste, #greenpass, #portualidrieste, #novax, #draghi
#portualitrieste

Betweenness for the period November - December 2021

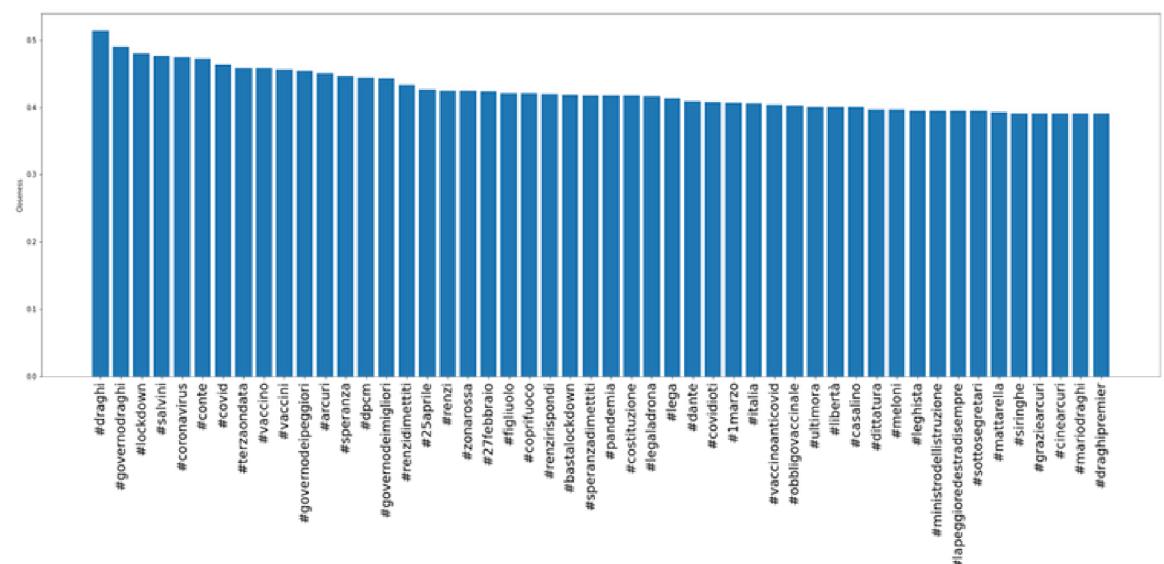
#draghi, #greenpass, #governodeipeggiorni, #covid_19, #vaccino, #dittaturasanitaria

Closeness analysis



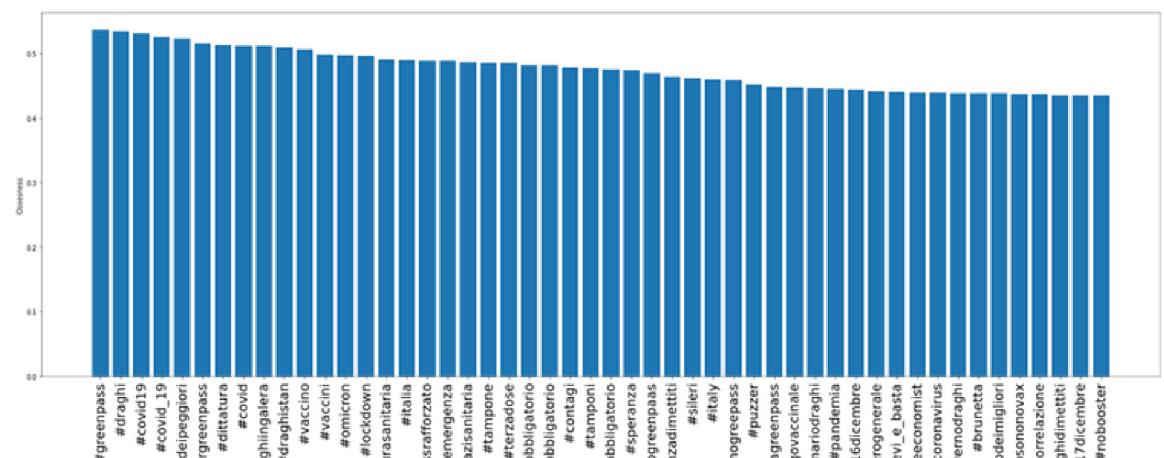
Closeness for the period January - May 2021

#draghi, #governodraghi, #lockdown, #salvini, #coronavirus, #conte, #terzaonda



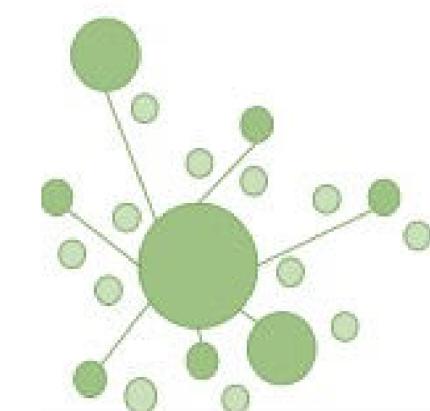
Closeness for the period October 2021

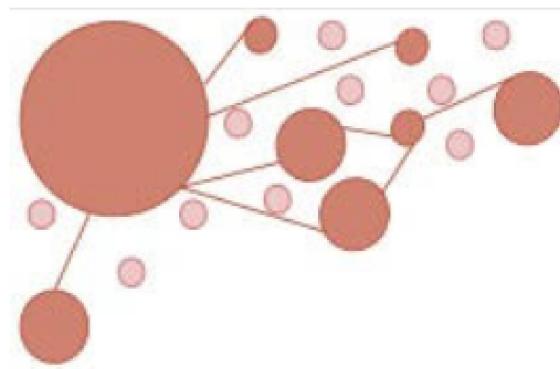
#greenpass, #trieste, #draghi, #nogreenpass, #novax, #portualiditrieste



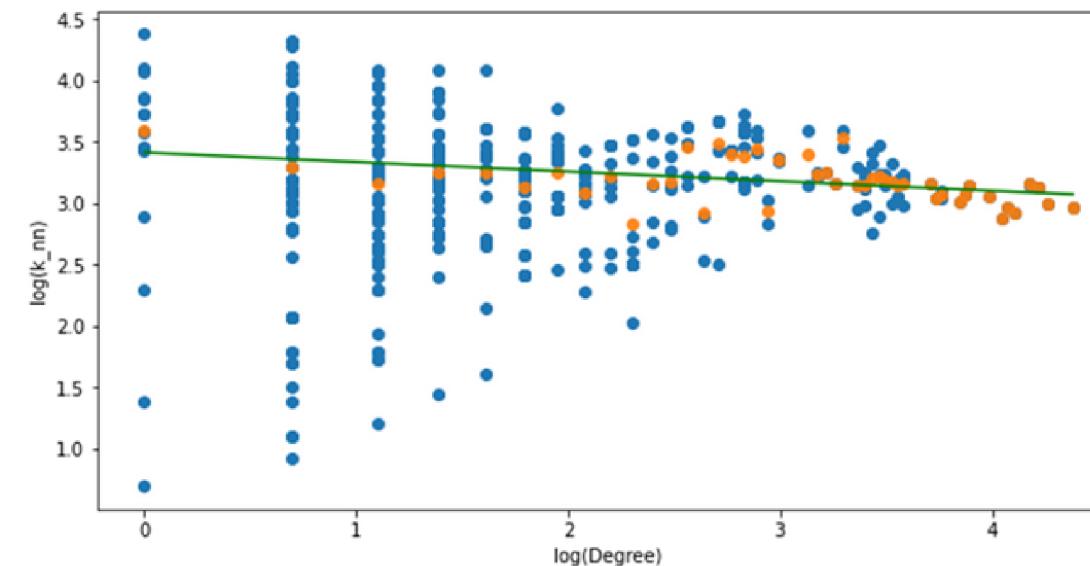
Closeness for the period November - December 2021

#greenpass, #draghi, #covid_19, #governodeipeggi, #supergreenpass, #dittatura

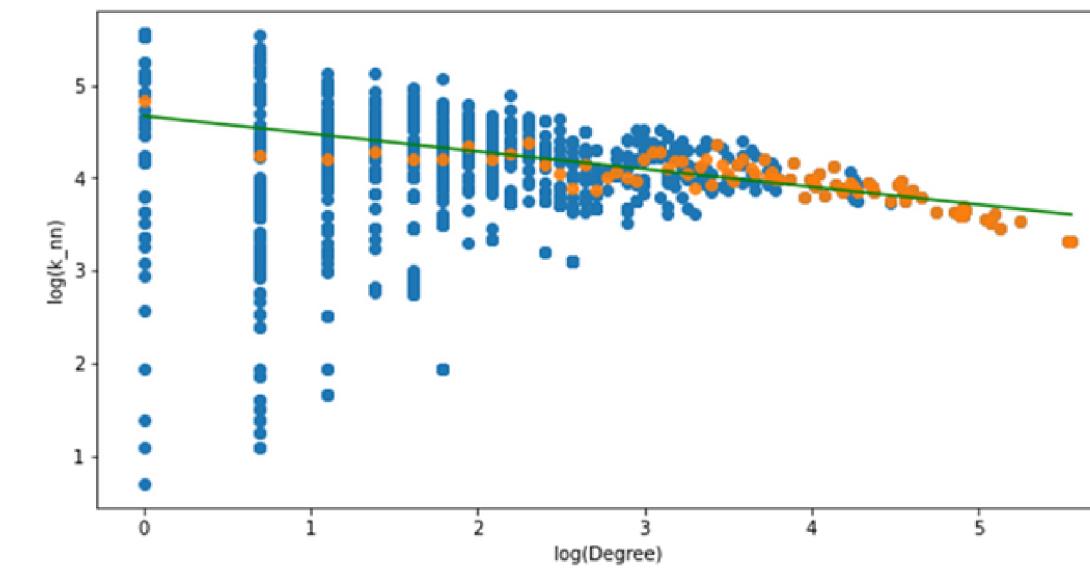




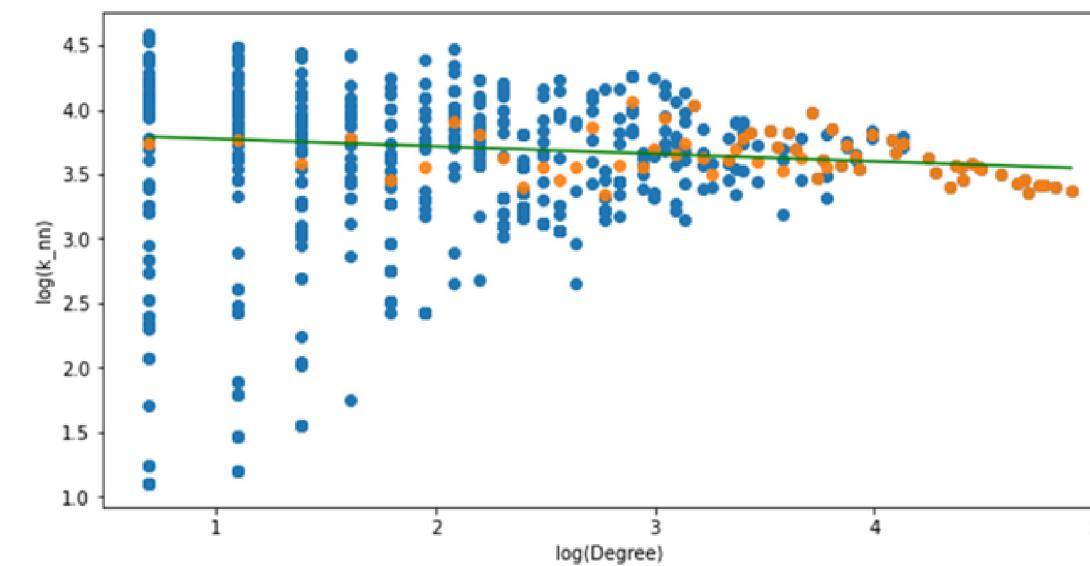
Assortativity



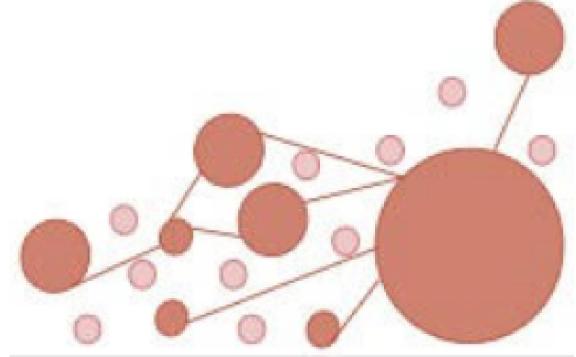
Januray/May 2021
Assortativity: -0.0922

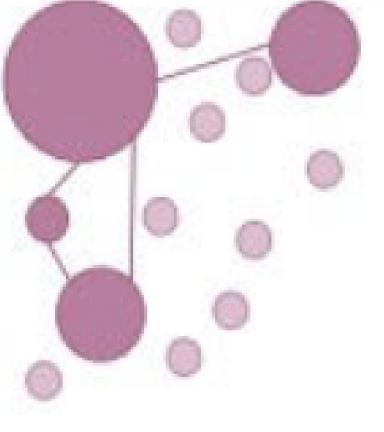


October 2021
Assortantivity: -0.1823

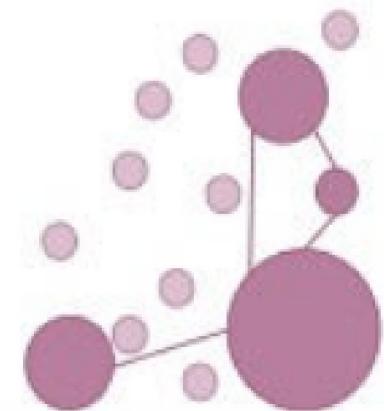
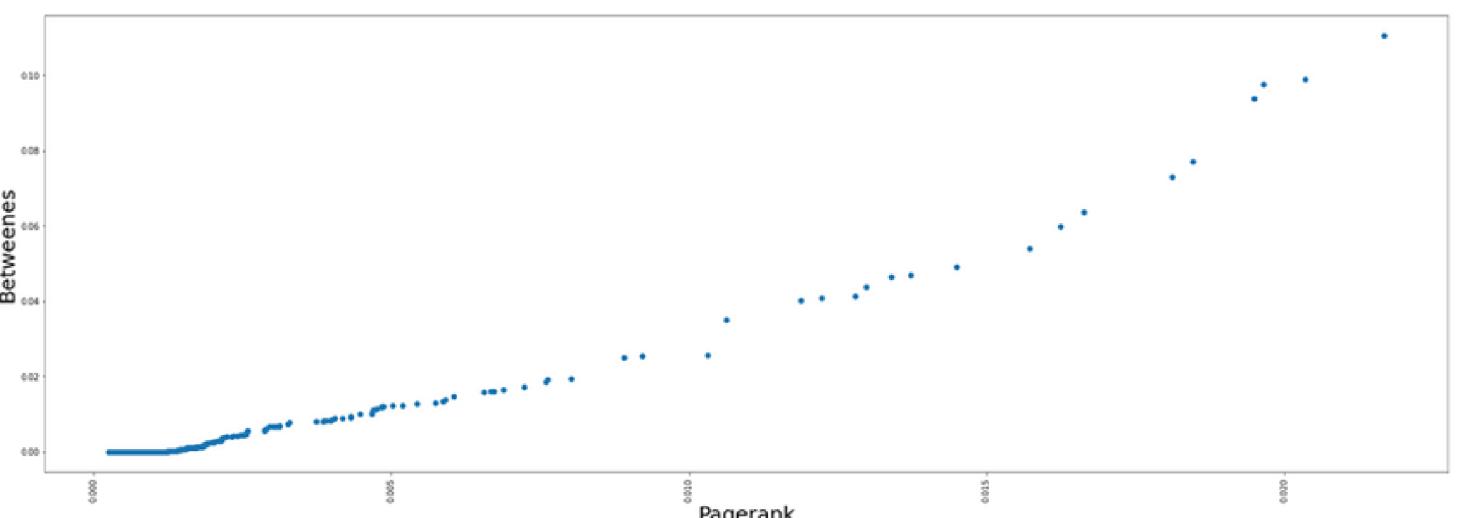
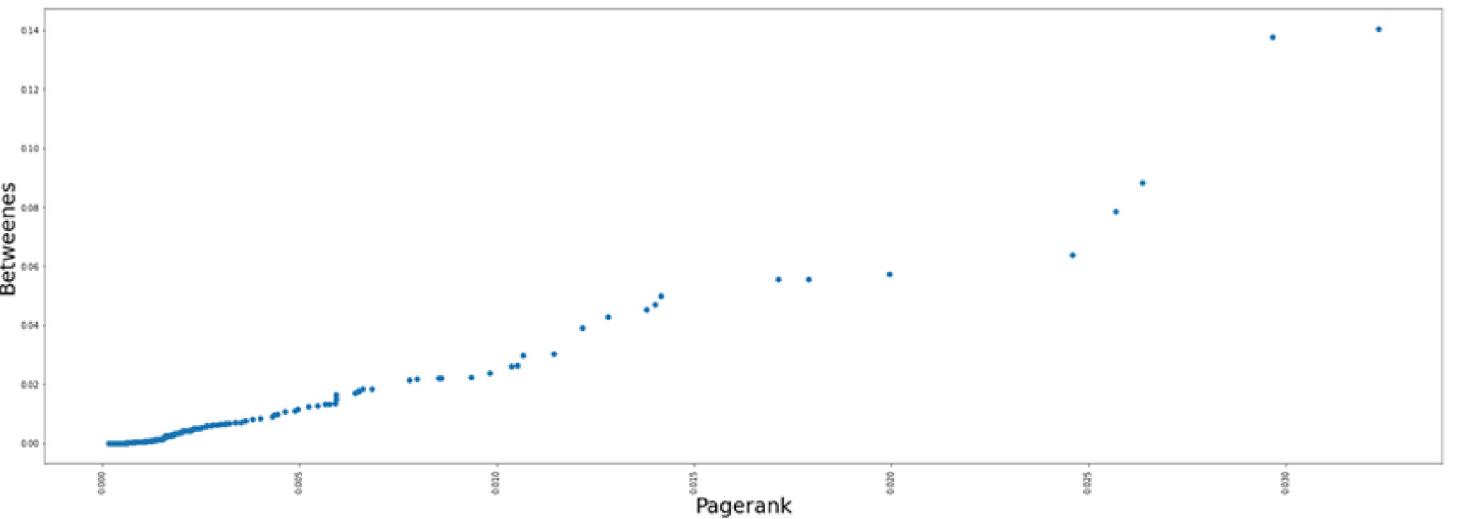
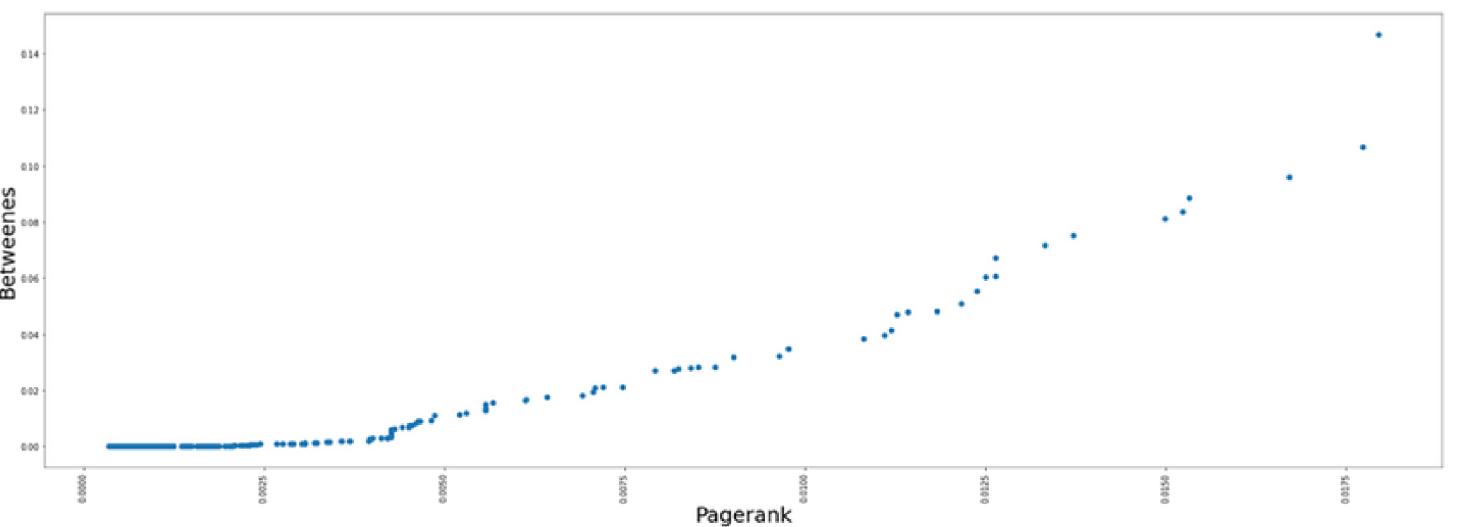


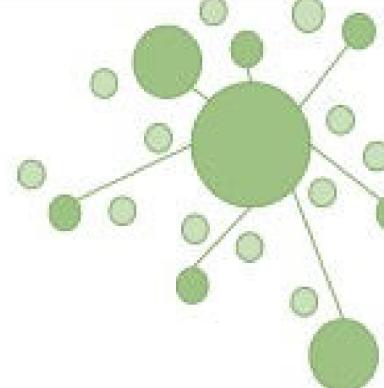
November/December 2021
Assortantivity: -0.1184



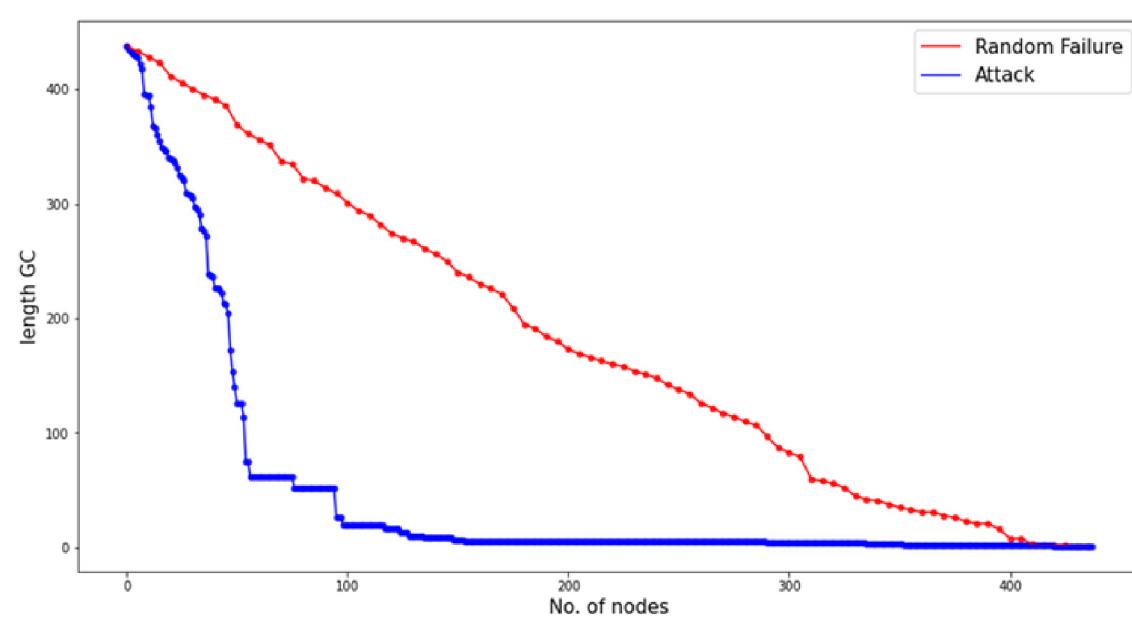


Pagerank vs Betweenness

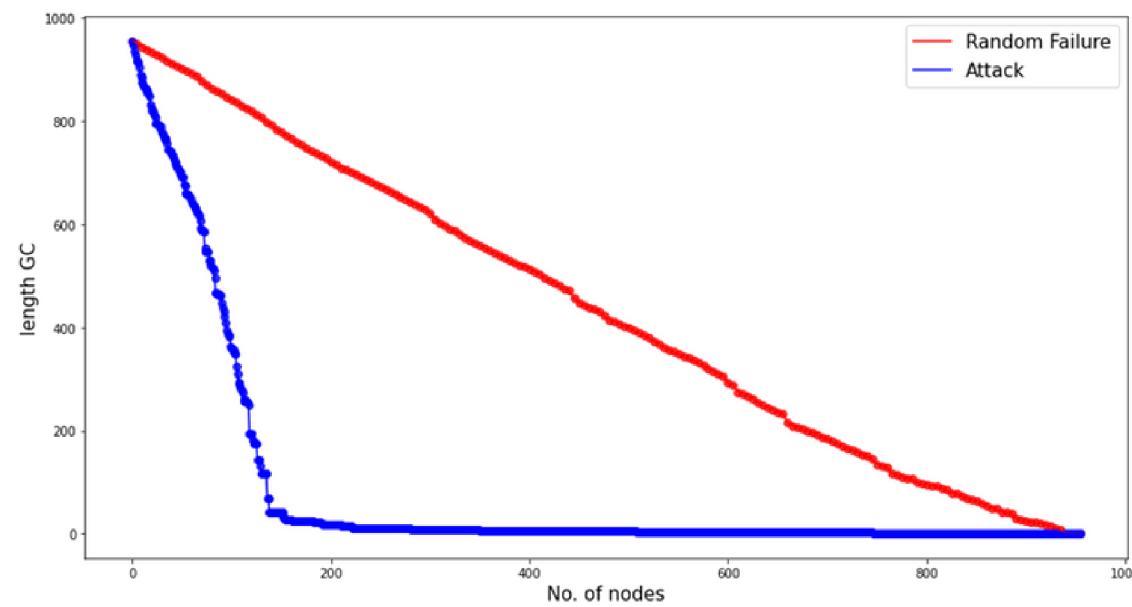




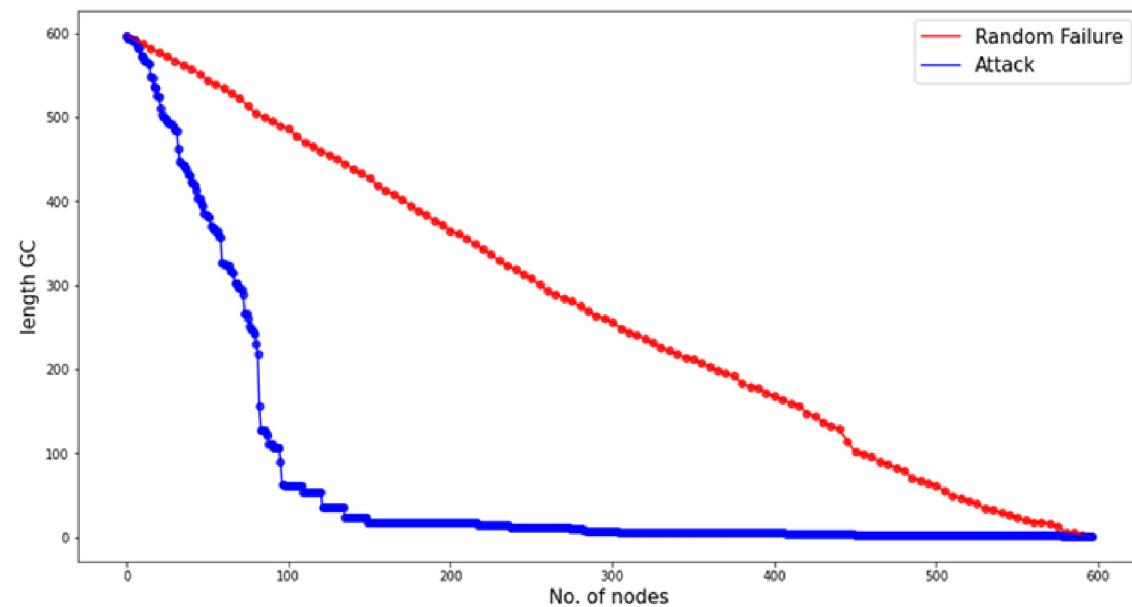
Robustness



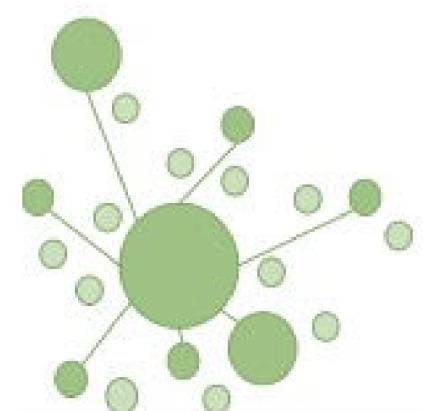
January/May 2021

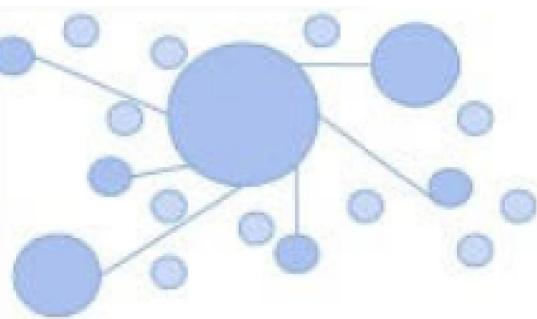


October 2021



November/December 2021

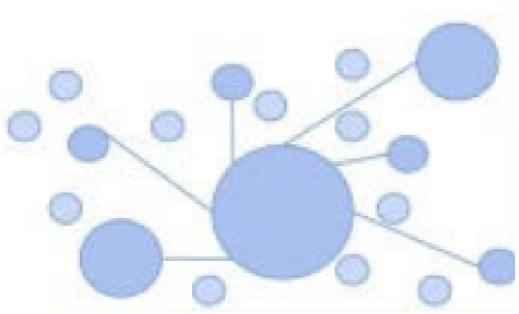




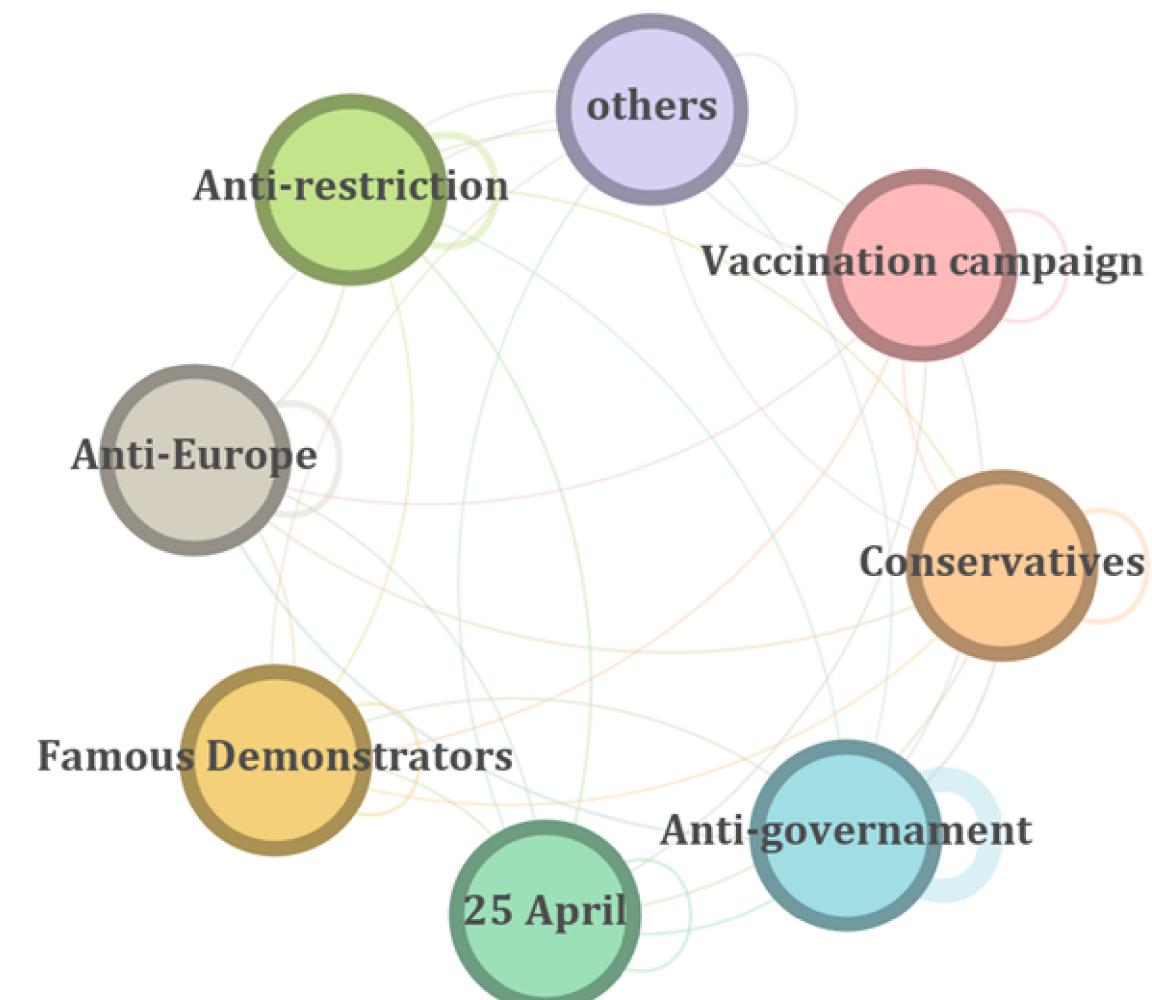
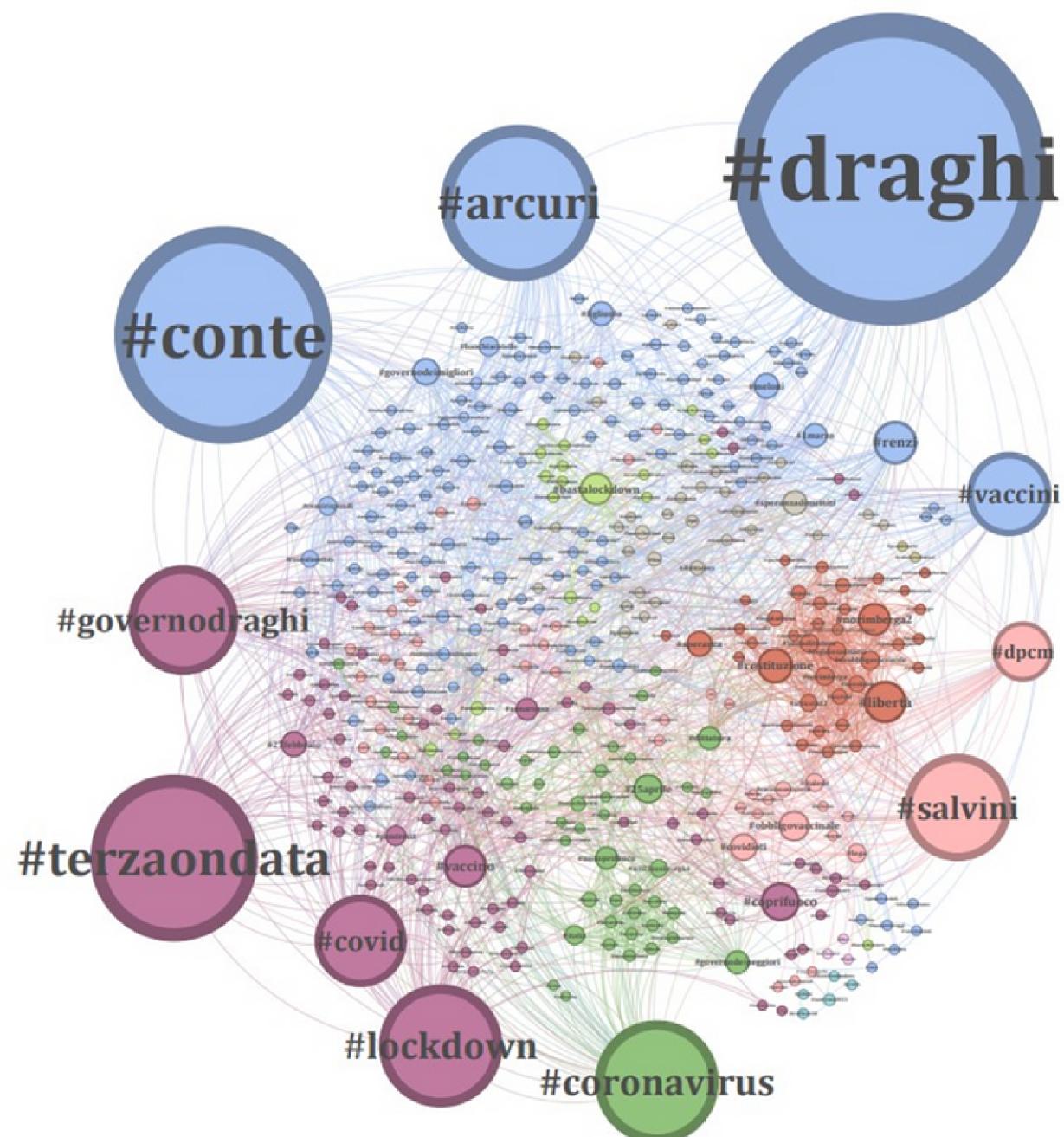
Community Detection

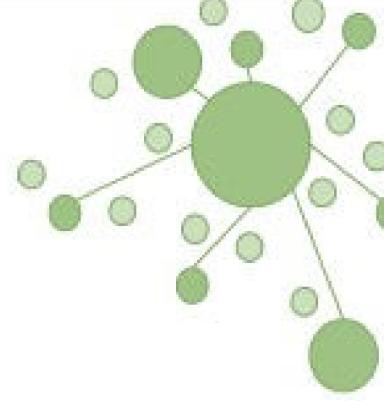
- Louvain's Algorithm (greedy algorithm): it has been ran 6 times for each network and then the results with highest modularity were chosen.
- 2022 does not have a good community structure.
- Pre-Vax has good communities, but unrelated with no-vax speech.
- We focus on the 3 networks in the middle.

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



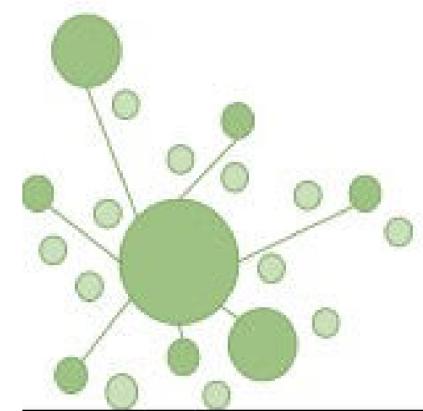
Community Detection
January 2021-May 2021



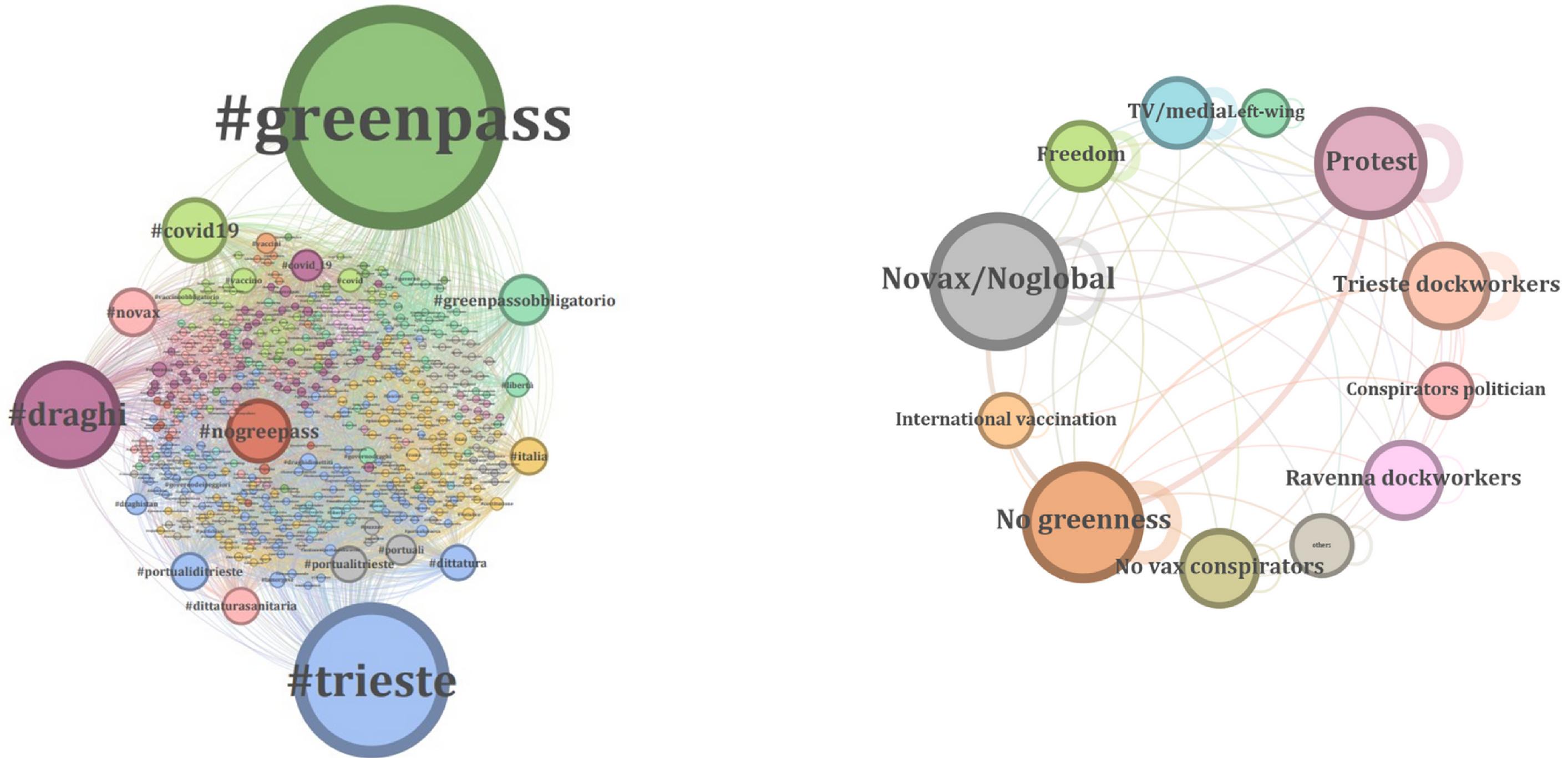


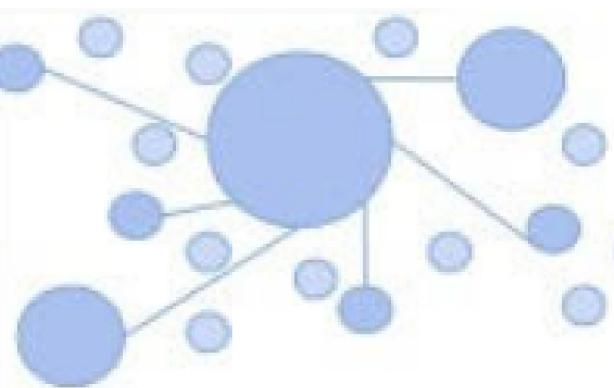
Community
Detection
Jan/May 2021

Community name	Descriptive hashtags
Anti-restriction	#coronavirus #italia #novax #nocoprifuoco #farsavirus
Vaccination campaign	#conte #draghi #arcuri #vaccini #dittatura militare
Conservatives	#coprifuoco #lega #salvini #lockdown #dpcm #dirittoanonvaccinarsi
Anti-government	#costituzione #norimberga2 #bastadittatura #noveleno
25 April	#25aprile #nolockdown #ioapro #antifascistisempre #resienza
Famous demonstrators	#tso #fano #mascherina #speranzadimettiti #dldittatura #iostoconrosanna
Anti-Europe	#obbligovaccinale #vaccinoanticovid #italexit #covidioti
Others	#polizia #sanremo2021 #gratis #collaborazionisti

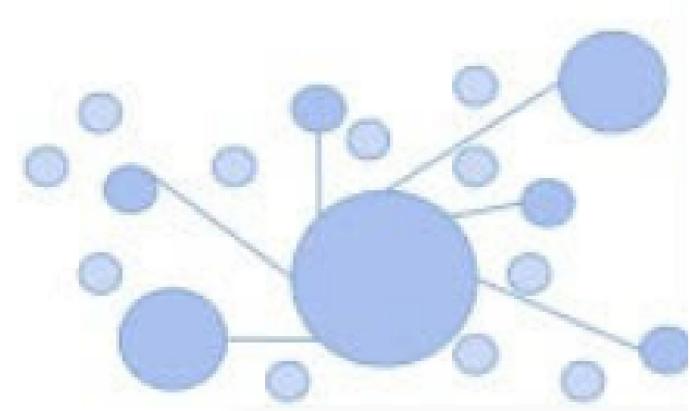


Community Detection
October 2021

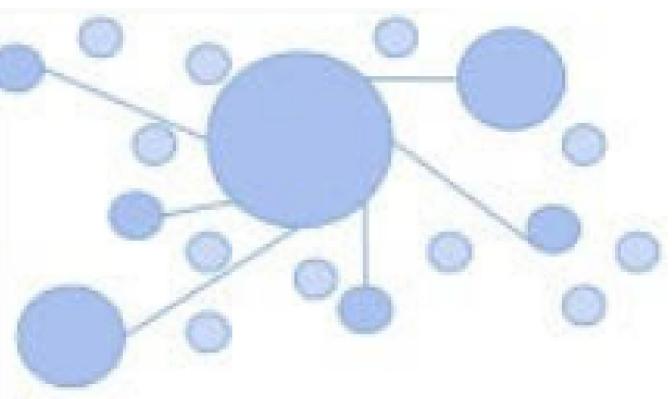




Community Detection October 2021

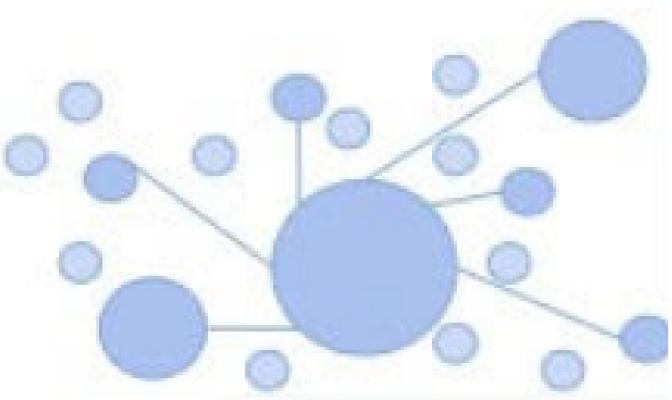


Community name	Descriptive hashtags
Conspirators politician	#barillari #cunial #ladittaturanonsapeteccosasia #17ottobre
Novax conspirators	#fascista #mainstream #fateschifo
No greeness	#covid19 #draghi #vaccino #vergogna #nogreenpass
International vaccination	#vaccinazione #antivax #moldavia #bulgaria #ucraina #montenegro #estonia
Novax/Noglobal	#greenpassobbligatorio #g20 #austria #g20summit #g20italy #g20leaders
Freedom	#liberta #liberascelta #studenticontrolgreenpass
Tv/media	#vaccini #merluzzi #drittoerovescio #zonabianca #sieromagico #sileri
Left-wing	#sinistra #facciamorete #sardine #m5s #pdnetwork #antifascismo

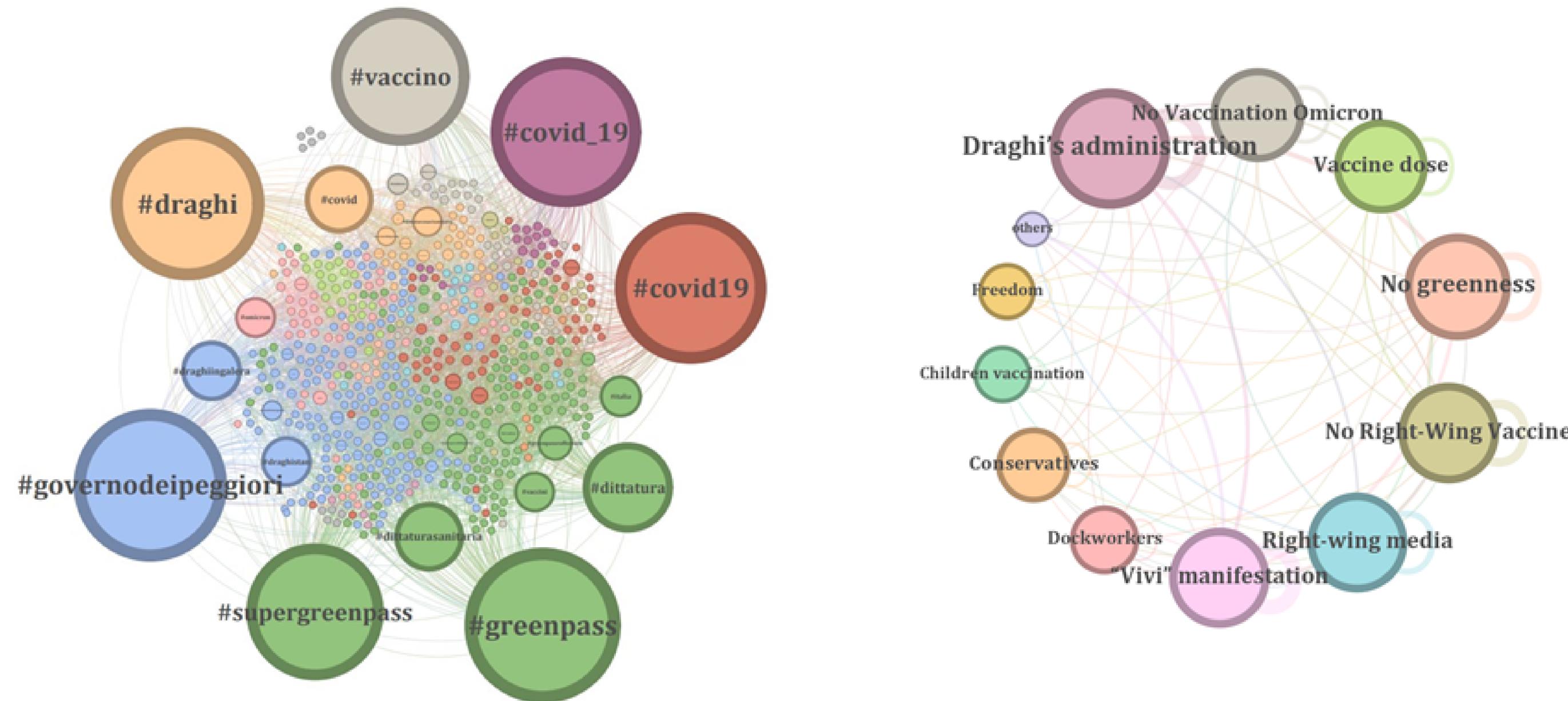


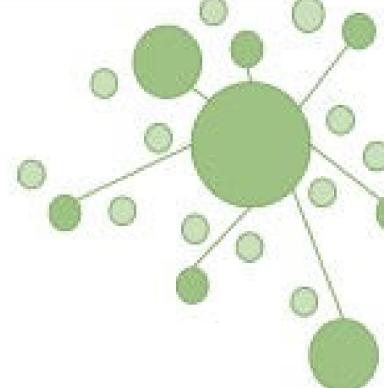
Community Detection October 2021

Community name	Descriptive hashtags
Trieste dockworkers	#portualitrieste #portuali #trieste
Protest	#trieste #portualiditrieste #dittatursanitaria #piazzadelpopolo
Ravenna dockworkers	#portichiusi #fincantieri #ravenna #portualiravenna #merlino

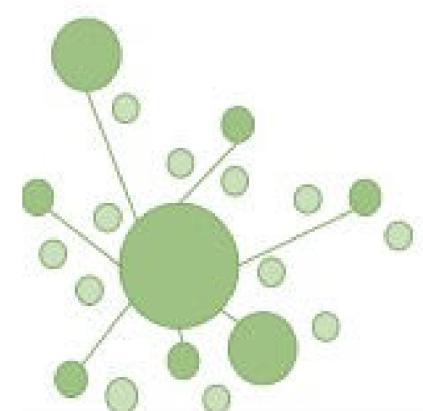


Community Detection
November 2021–December 2021

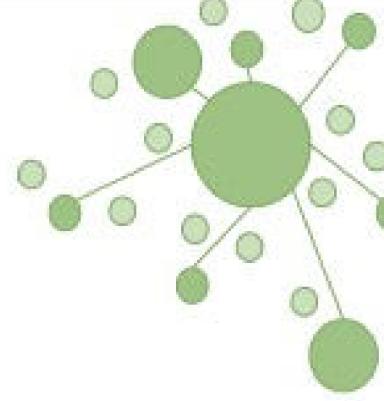




Community Detection Nov/Dec

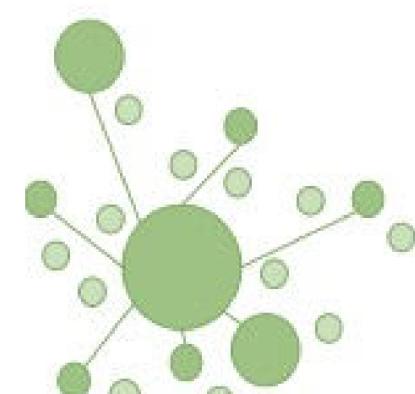


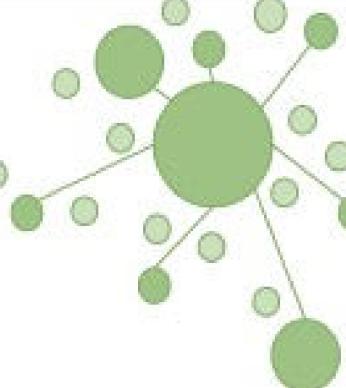
Community name	Descriptive hashtags
Right-wing media	#28dicembre #cruciani #lazanzara #confindustria #bonomi #meloni
No Right-wing vaccine	#lockdown #vaccino #obbligovaccinale #borgonovo #bastadittatura #lariachetira7
Conservatives	#lega, #salvinipagliaccio #gratteri #4quirinale #salvinifaccetarzan #salvini
Children vaccination	#noobligovaccinale #bambini, #noapartheidvaccinale #novaccini
No Vaccination Omicron	#omicron #sileri #booster #pfizer #omicronvirus #conte #primule
Vaccine dose	#terzadose #quartadose #pfizergate #supercringepass



..... ● **Community
Detection
Nov/Dec**

Community name	Descriptive hashtags
"vivi" manifestation	#vivi #vaccinoobbligatorio #ditturanazisantaria #iosononovax
Dockworkers	#genova #portualidigenova #puzzo #democrazia #pordenone #lagentecomeno in non molla mai
Draghi's administration	#draghiingalera #draghistan #governodei peggiori #draghibugiardo
No greenpass	#greenpass #supergreenpass #dittatura #ditturasanitaria
Freedom	#libertà #democraziavirale, #demagogiasolidale #ivermectina #idrossiclorochina #discriminazioni

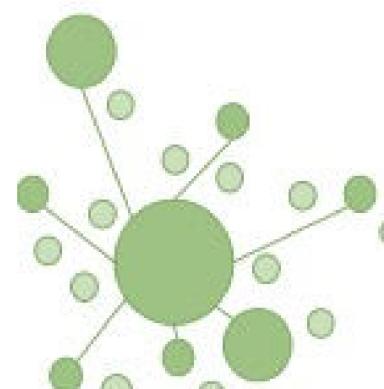


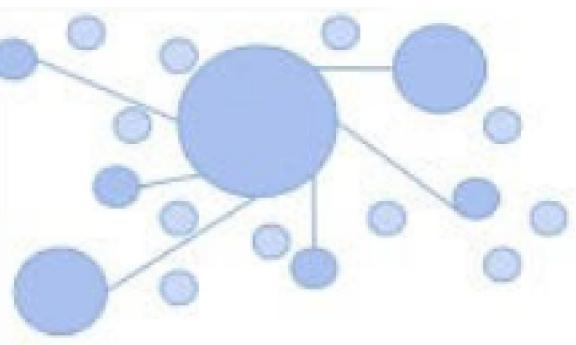


Community Detection Nov/Dec



Community name	Descriptive hashtags
"vivi" manifestation	#vivi #vaccinoobbligatorio #dittaturanazisana #iosononovax
Dockworkers	#genova #portualidigenova #puzzo #democrazia #pordenone #lagentecomeno in non molla mai
Freedom	#libertà, #democrazia virale, #demagogia solidale, #ivermectina, #idrossiclorochina, #discriminazioni,





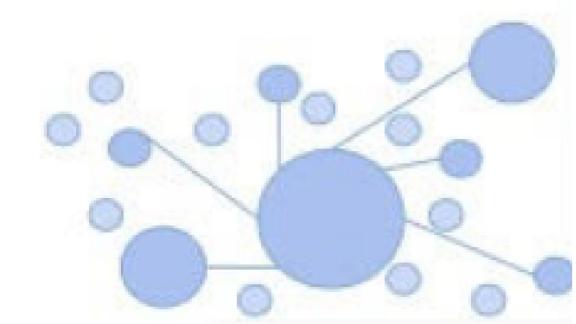
Semantic analysis

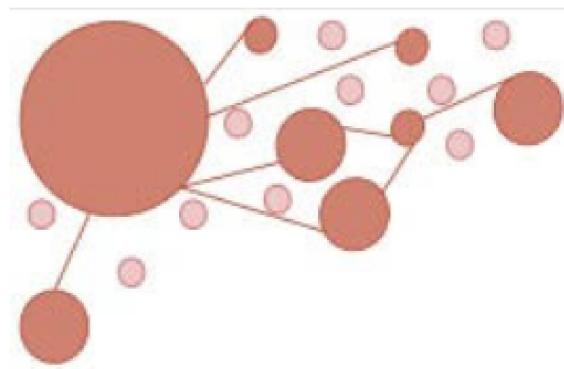


Text cleaning

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

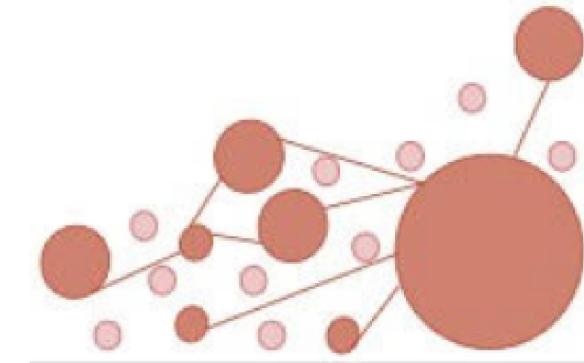
Python was used to filter the text in the following order

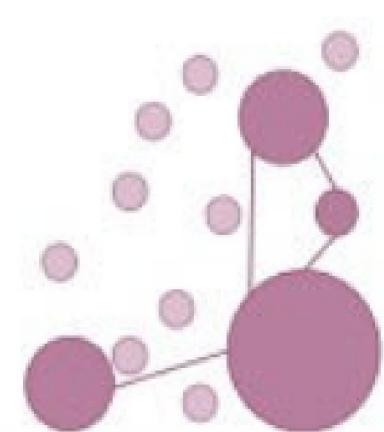
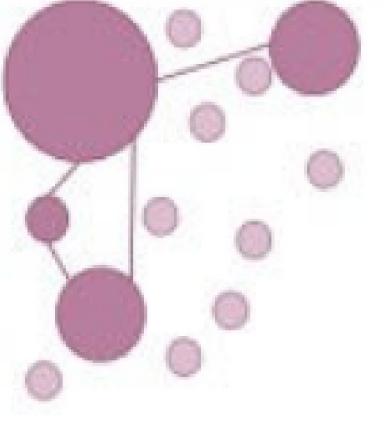
- removal of links;
 - removal of mentions (@);
 - removal of the hash symbol (#);
 - removal of the RT acronym;
 - removal of the traits _ and - ;
 - used the hashtag words (without #) and put them in lower case with spacing;
 - the emoji have been coded in Italian
- 



LiWC

LIWC is a psycho-linguistic 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.

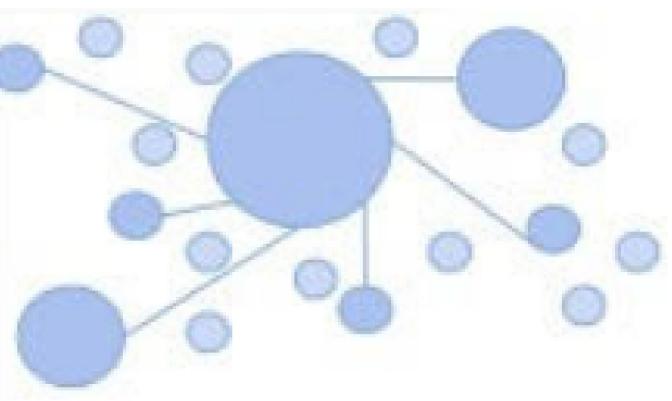




• Liwc's dictionary

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;

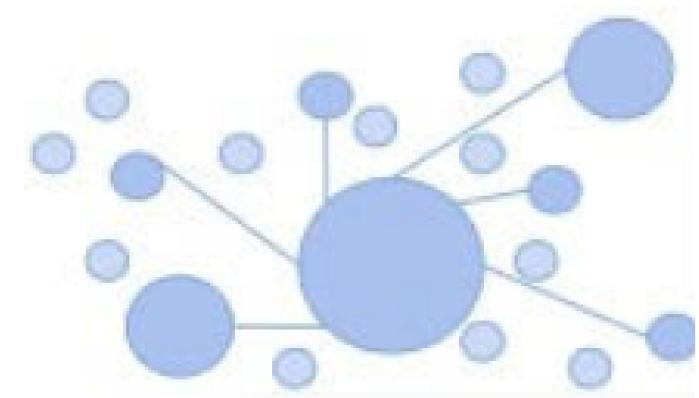




Liwc results

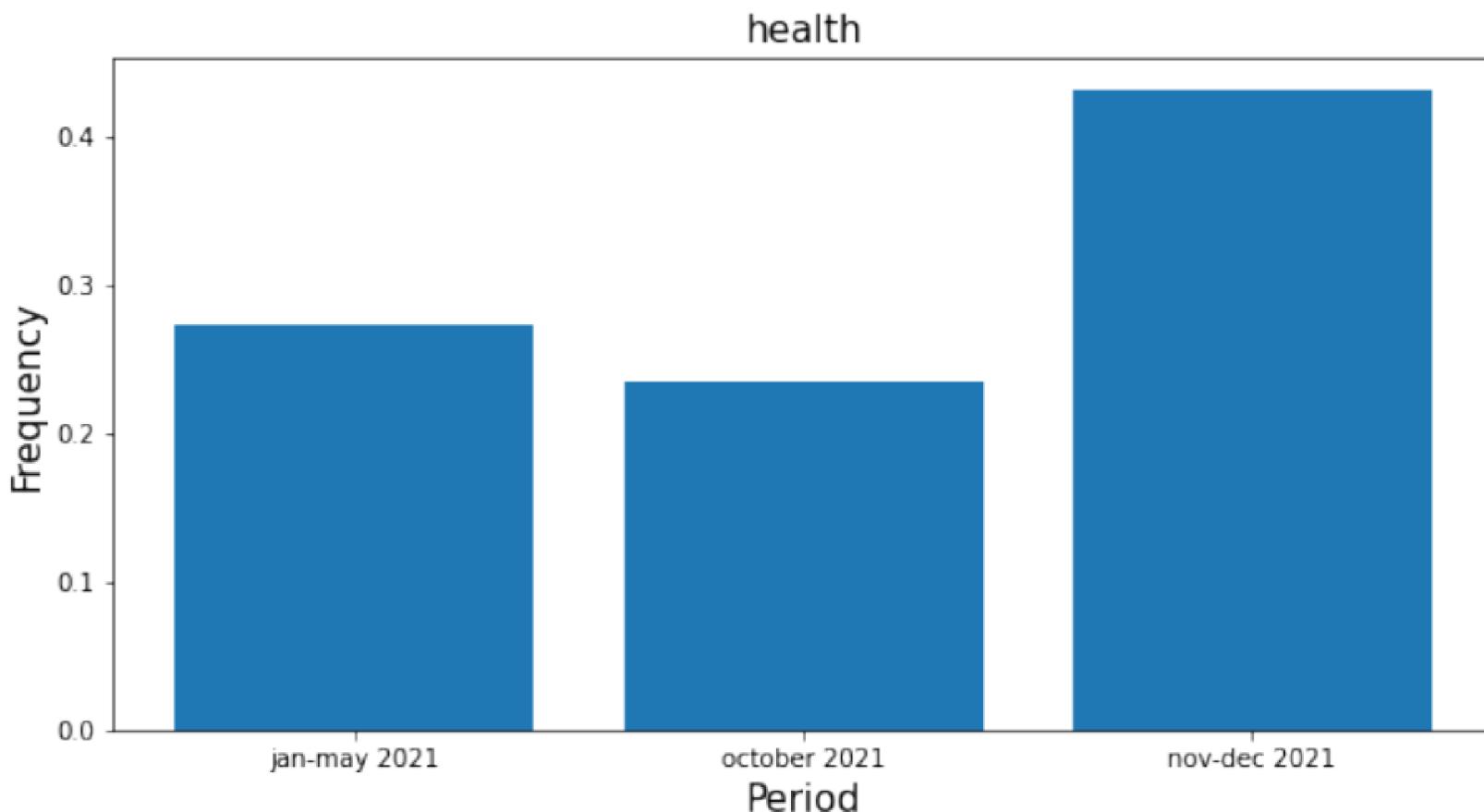
The dynamics that govern our being around others are numerous and complex. This also occurs in social media.

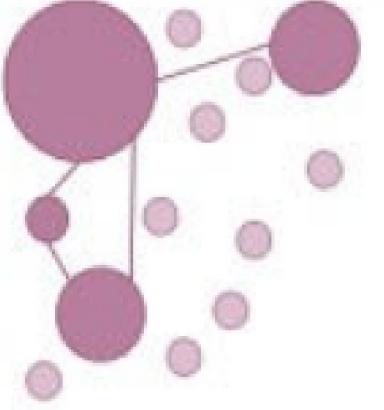
Our focus is on the social interaction of the Novax communities on Twitter, the main topics discussed on it and consequently the messages that generated the most social interaction



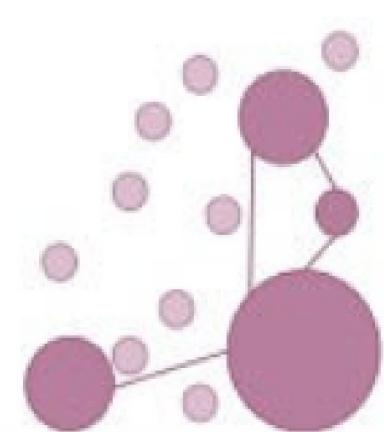
.....o Health

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



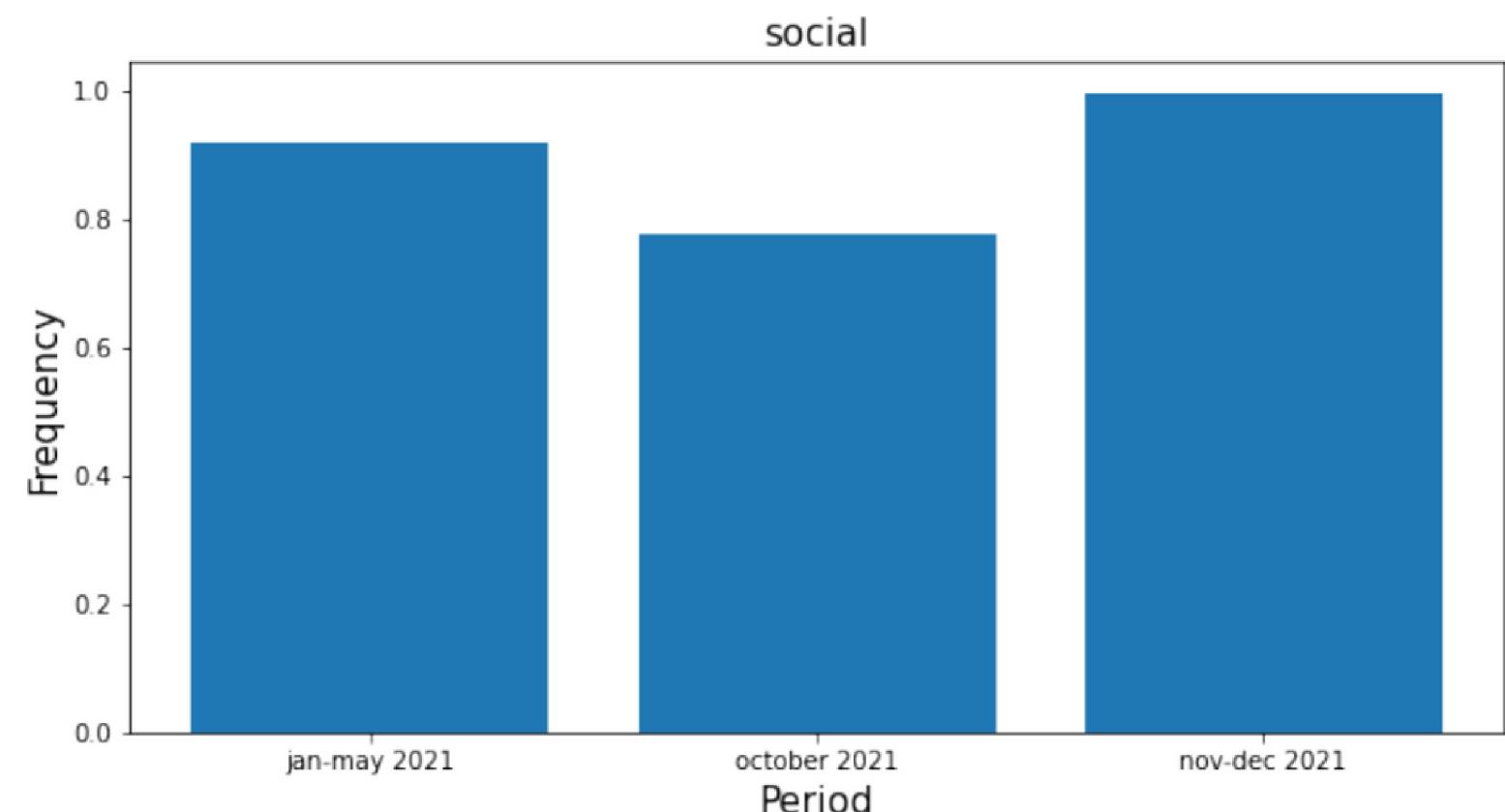


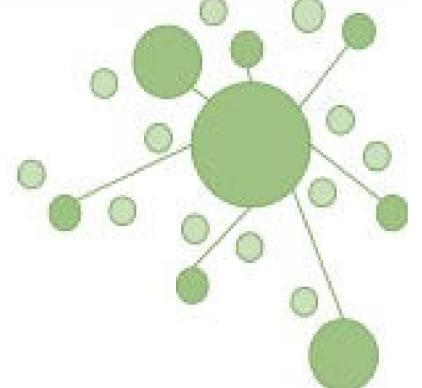
Social



In the third network there was a lot of social interaction between the Novax people as they had a lot to talk about and discuss.

The Novax communities with the highest peak are those dealing with dockworkers, protests, and negative sentiments against the government. This is because the right wing was against the green pass, decided by the party that was in government at the time.

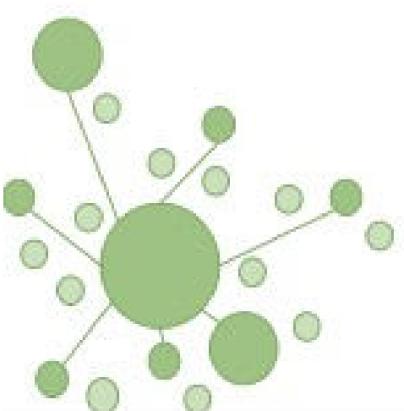
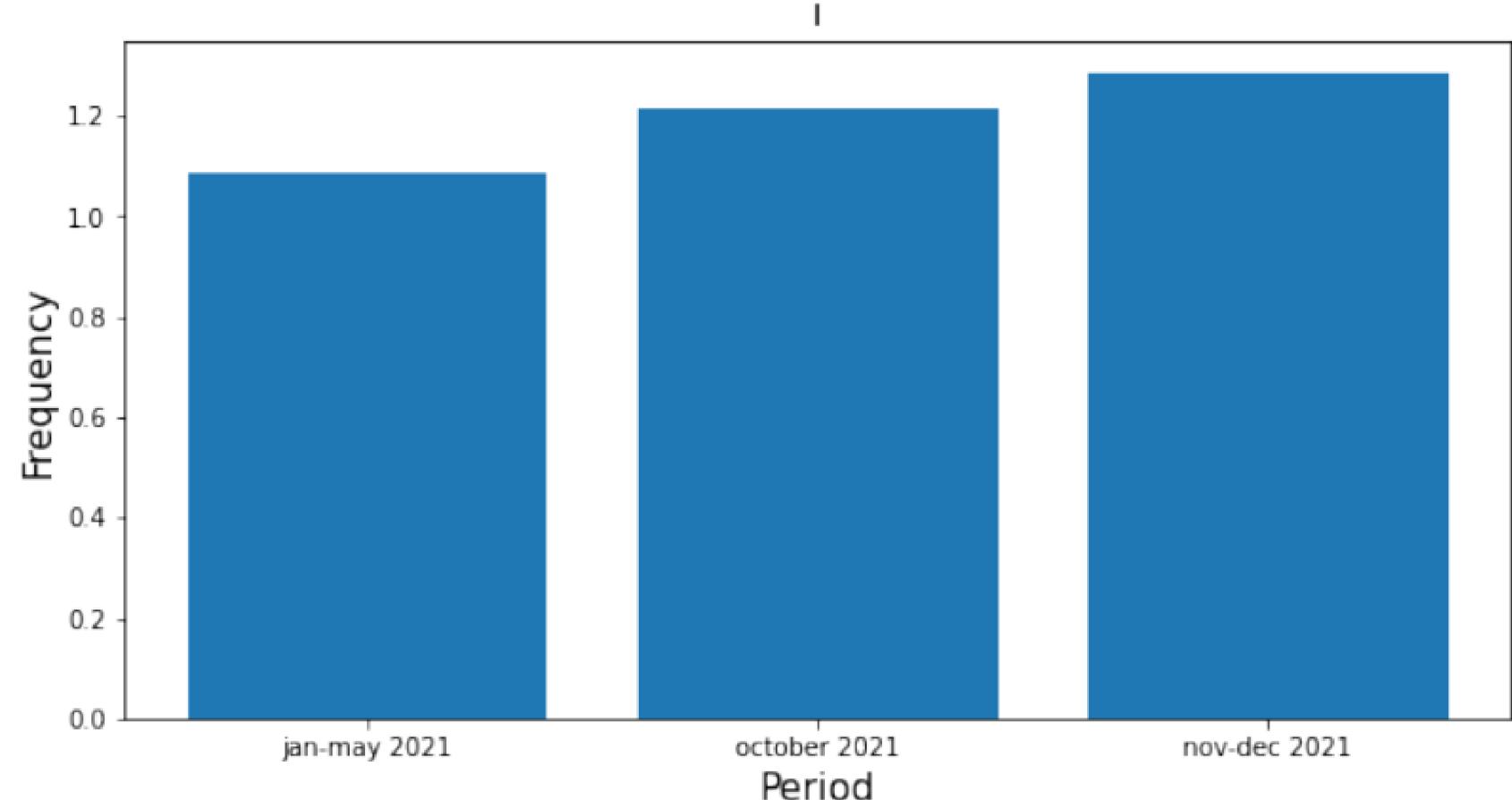


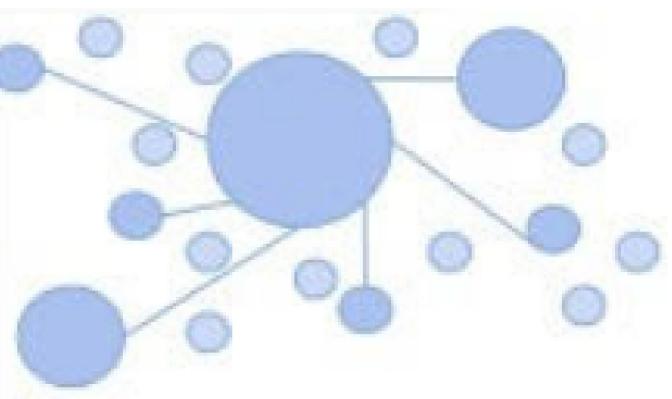


Pronouns

It emerged that participants used more first-person singular pronouns.

The Novax communities put themselves, their thoughts, their negative emotions about the solutions adopted by the government at the centre.

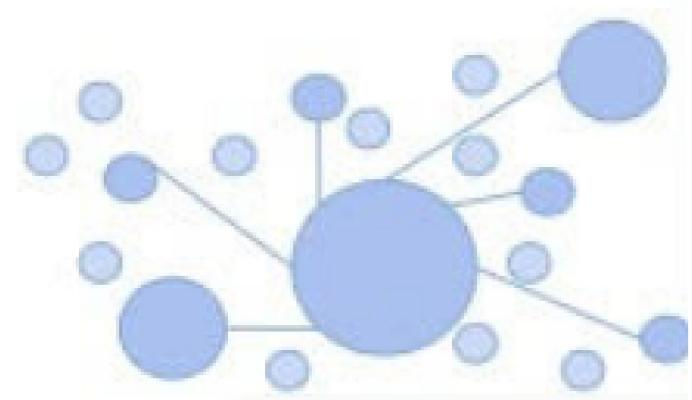
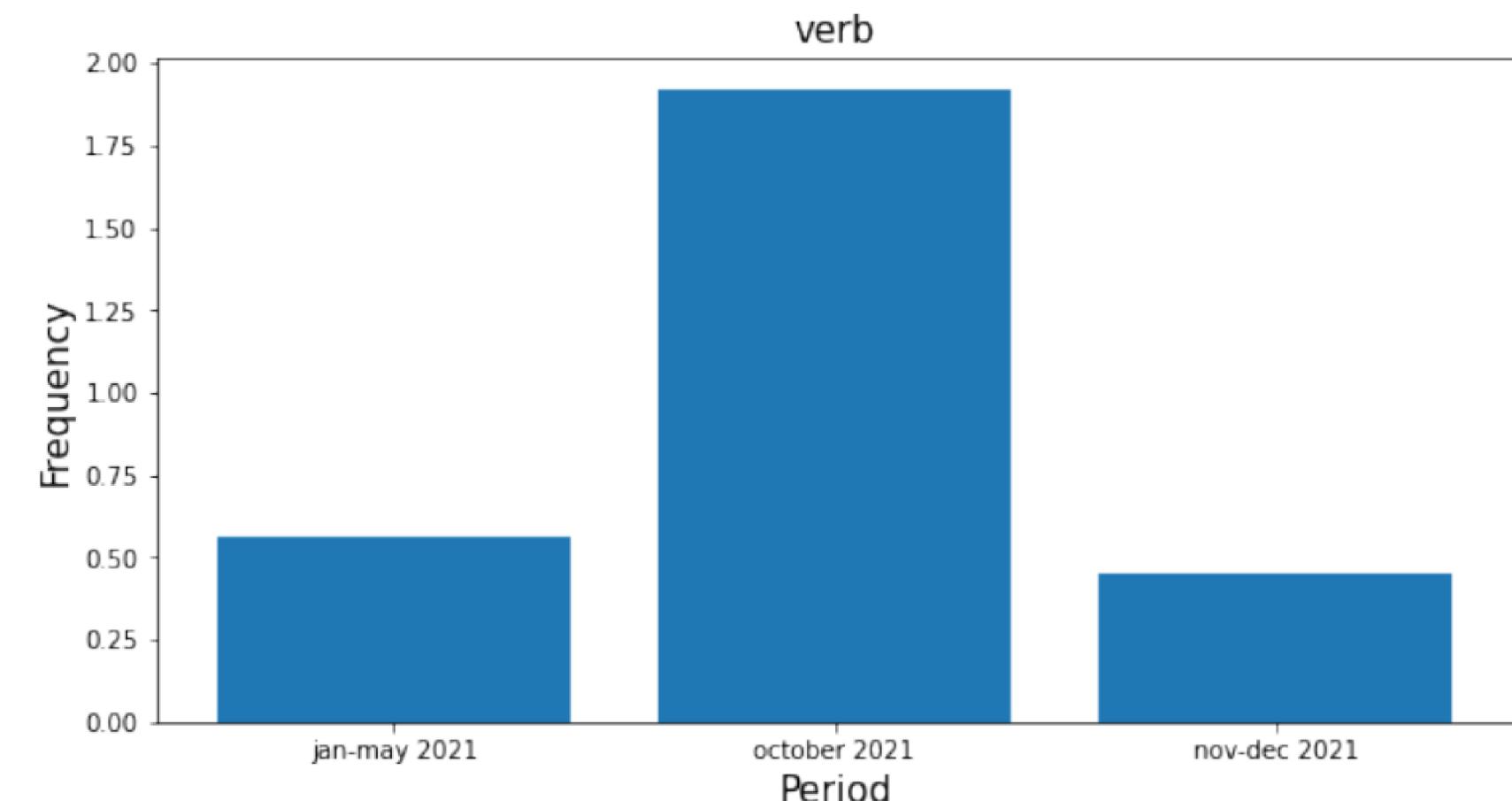


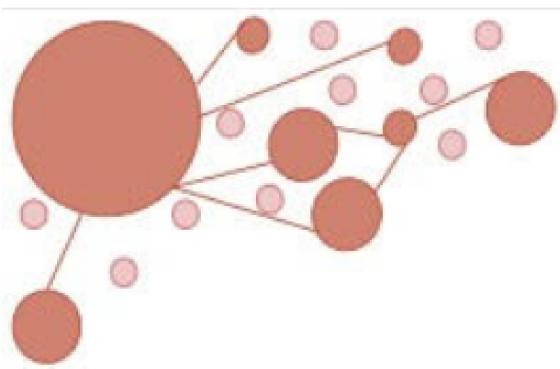


Verbs

Verbs are markers of agency. This concept concerns both individuals and groups, and is expressed in the ability to generate actions directed towards certain goals and/or objectives.

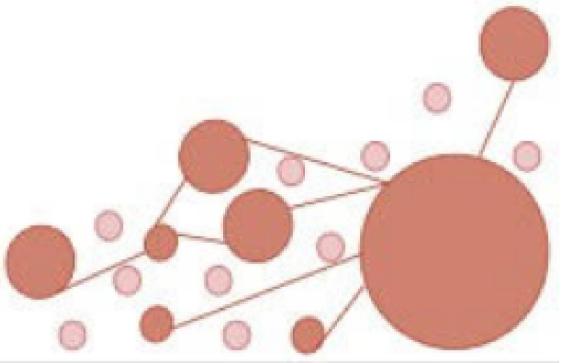
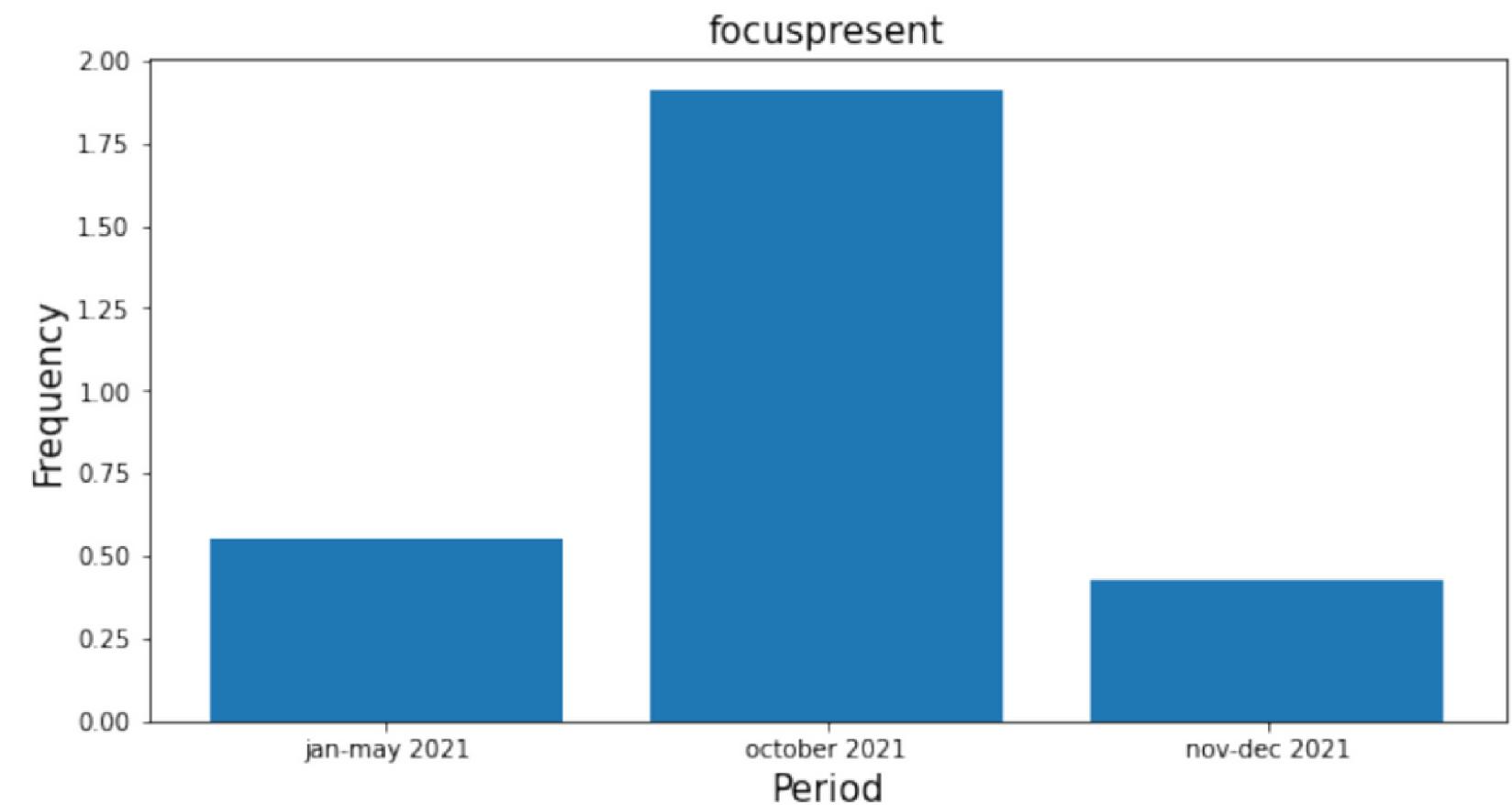
In fact, the communities which use more verbs the most are those that have to do with protests.





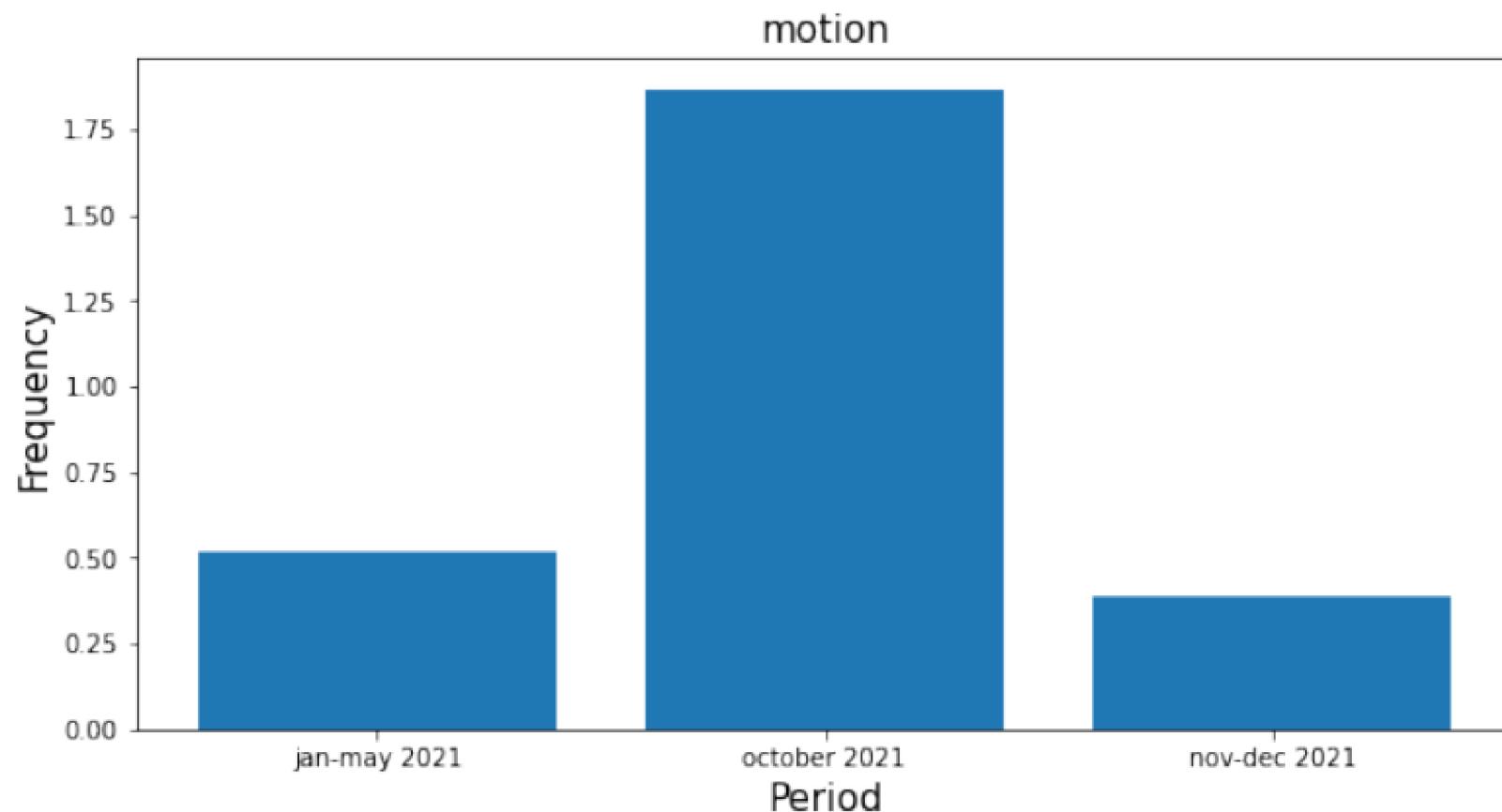
Focus present

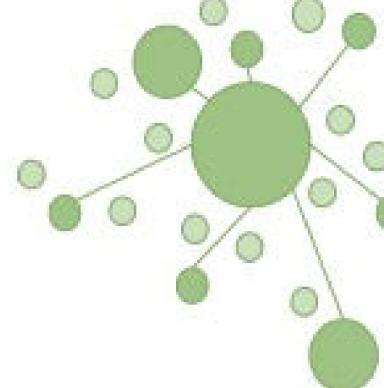
Novax communities mainly focused in the present time. The tendency to think in the present was associated with the Novax' interest in the issues of that time: the compulsory green pass and the vaccination doses that were required to carry out everyday activities.



Motion

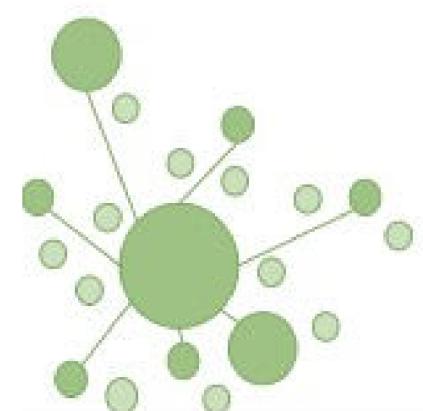
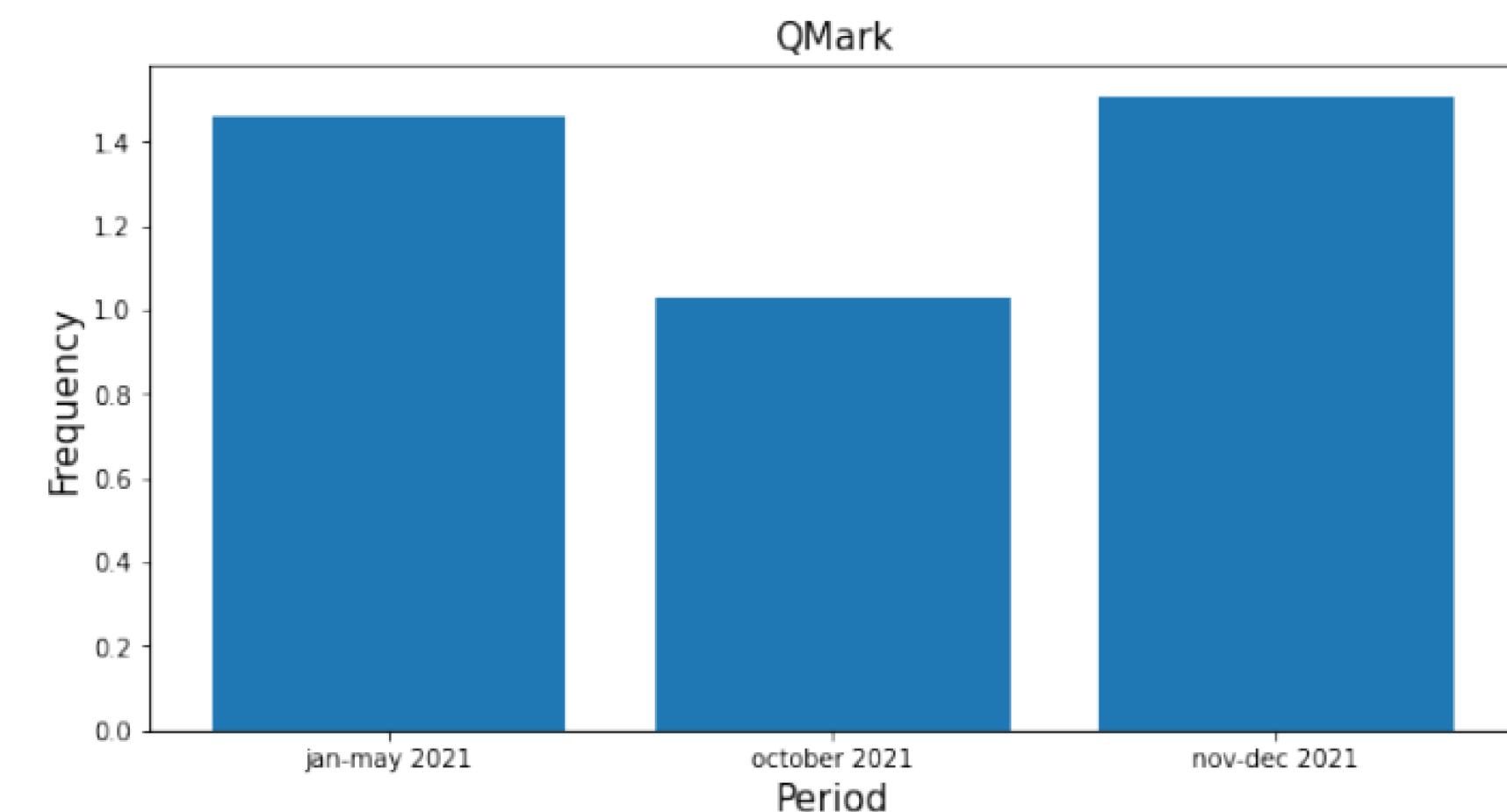
The use of movement words was due to the protests and manifestations against the vaccine campaign.

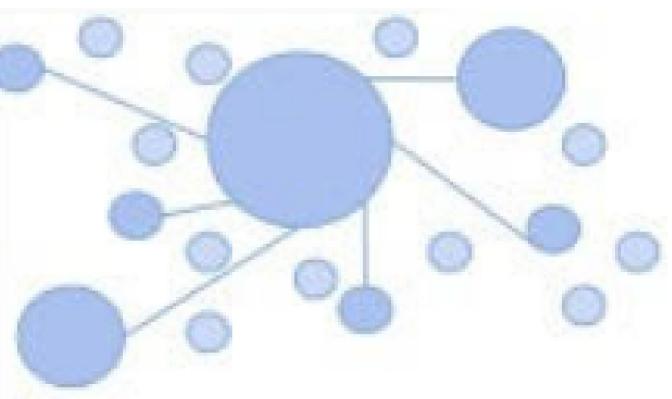




Question marks

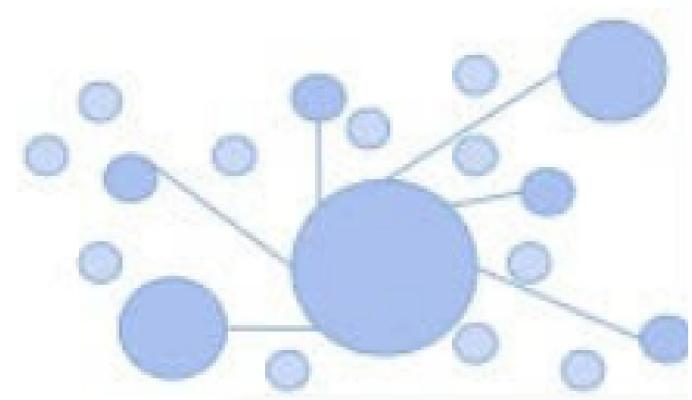
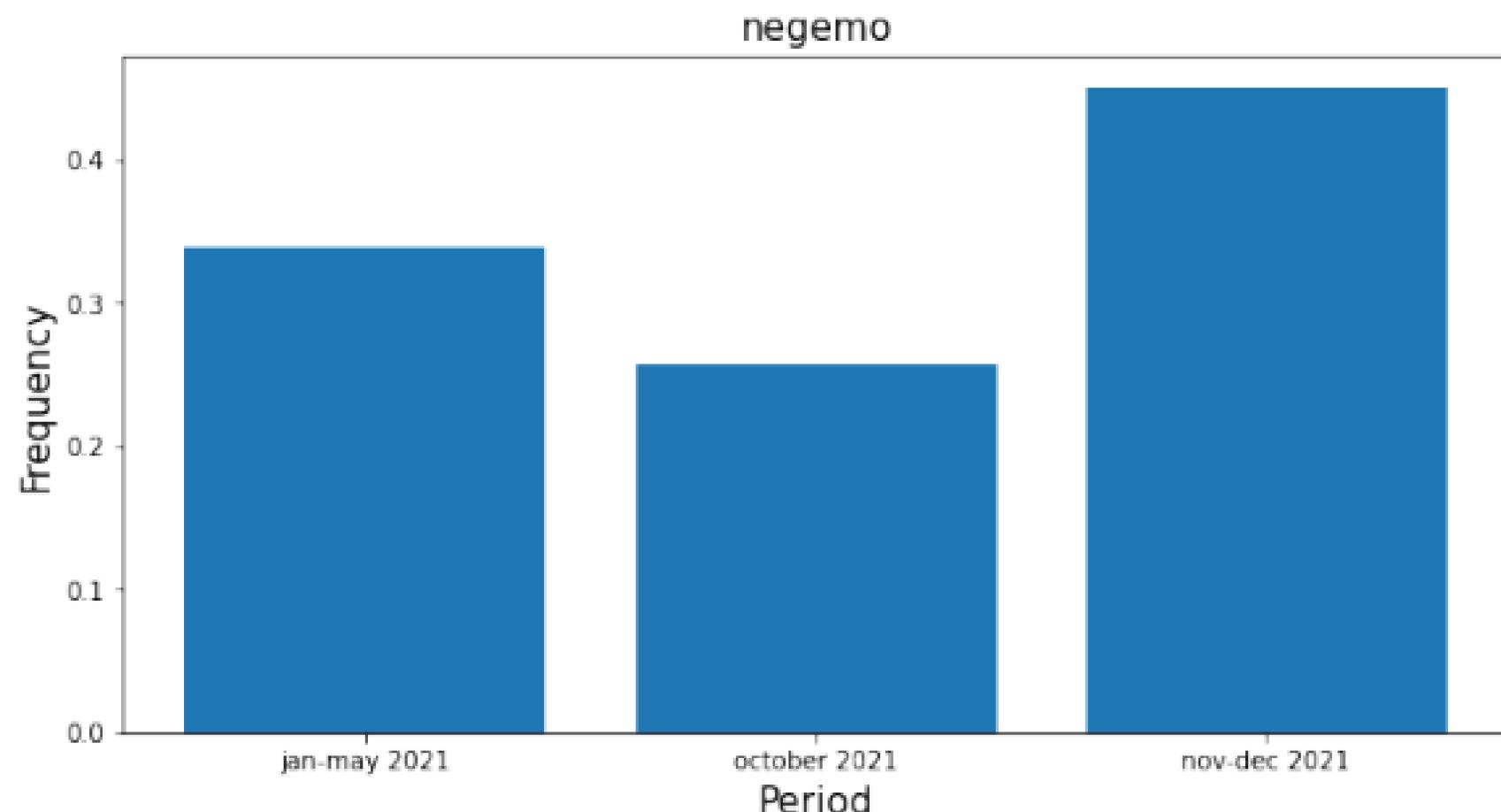
The use of the question mark is usually meant in an insolent and sarcastic manner and often are rhetorical questions, mockery of vaccinations and government-induced restrictions.

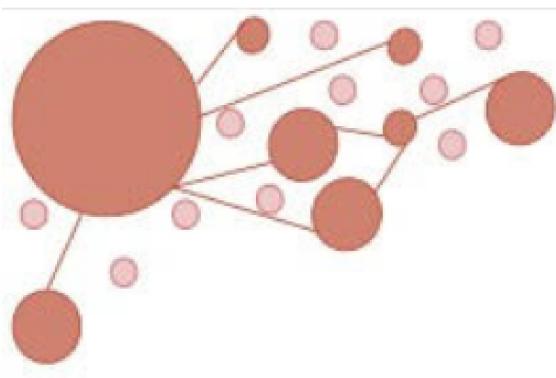




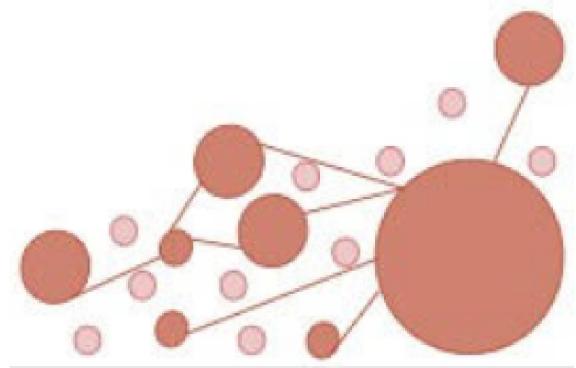
Negative emotions

One can understand that the main negative emotions are therefore connected to feelings of disagreement rather than fear.

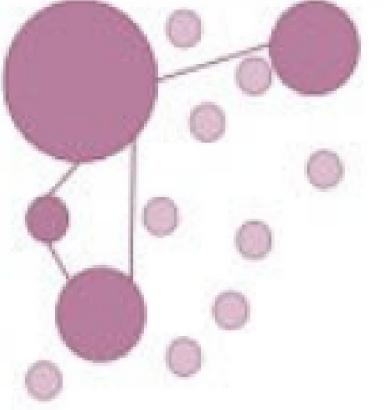




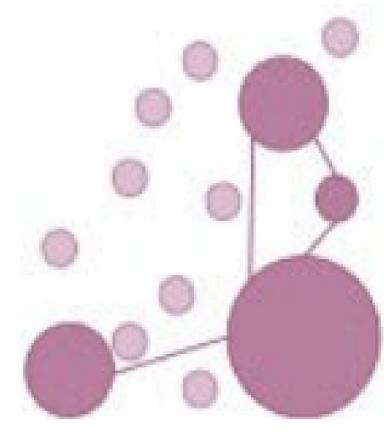
Conclusion

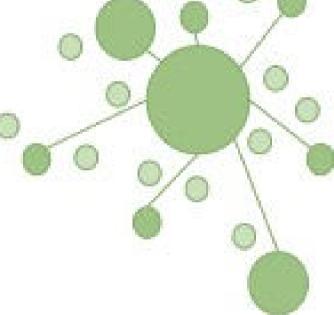


- For each period we downloaded the hashtags from Twitter using the same queries. We found that:
- They were free scale networks and disassortative.
- We were able to capture communities related to the no-vax speech only in the second,third and fourth networks.
- In the middle periods we detected different communities related to the no-vax speech. For each network the nuances of the speeches (such as protest, restriction anti "regime", etc..) have been investigated, along with their time evolution.



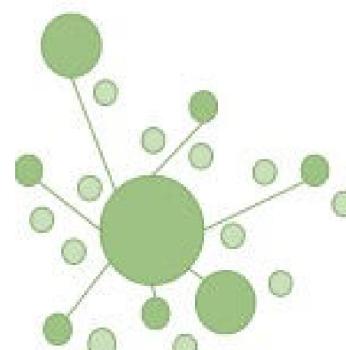
Conclusion

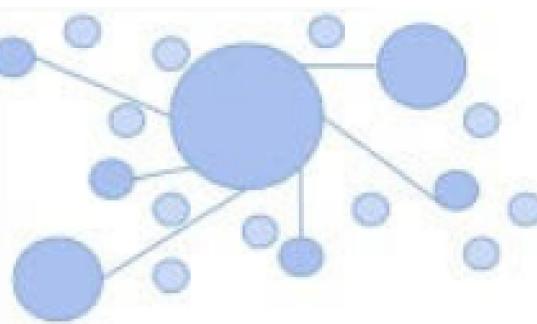
- Novax used Twitter mainly as a platform to express their complaints.
 - The Novax put themselves, their thoughts, their negative emotions about the solutions adopted by the government at the centre.
 - The main negative emotions are connected to feelings of disagreement rather than fear
 - The communities which use the most verbs are those that have to do with protests.
 - Novax communities mainly focused in the present time, and the use of movement words was due to the protests and manifestations against the vaccine campaign.
 - The use of the question mark is usually meant in an insolent and sarcastic manner.
- 



References

- 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.
- Ortiz-Sánchez E, Velando-Soriano A, Pradas-Hernández L, Vargas-Román K, Gómez-Urquiza JL, Cañadas-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/ijerph1715394. PMID: 32727024; PMCID: PMC7432886.
- 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.
- 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>"
- 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.
- 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.





Role of each participant in the project

Python Code

Matteo Pernini, Francesco Sartori, Pietro Sittoni

Gephi

Francesco Sartori

Results Analysis

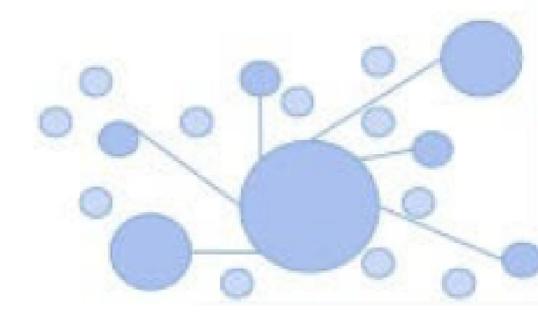
Matteo Pernini, Francesco Sartori, Pietro Sittoni, Arash Ahmadian,
Giulia Pettenazzo, Laura Rettore

Semantic analysis

Giulia Pettenazzo, Laura Rettore

Report part

Matteo Pernini, Francesco Sartori, Pietro Sittoni, Arash Ahmadian,
Giulia Pettenazzo, Laura Rettore





**Thank you
for your attention**