



University of Venice Ca' Foscari
SOCIAL NETWORK ANALYSIS

*Sentiment analysis of Twitter users
towards the Climate crisis based on
actions of environmental movements*

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1. Introduction

This report will detail the behaviour of users on a social media platform after witnessing actions committed by members of a certain environmental movement regarding the climate crisis, and then observing opinions about it. The movement in question is fighting to disseminate a warning message to as many people as possible who are willing to listen. Recently, activity has increased due to a single event that led to the spread of similar behaviour by other members of the same movement, resulting in an increase in online searches and discussions about it.

Especially in recent times in Italy, we have heard a lot about Just Stop Oil and Ultima Generazione, where climate activists vandalized works of art in museums to attract the attention of as many people as possible. The goal is to ensure that the government commits to stopping all authorizations for the development, export, and production of fossil fuels and climate change.

Many famous painters around the world have been targeted by young activists from environmental groups such as Just Stop Oil, Furto Vegetal, and Ultima Generazione (an Italian group). These groups of young people stage demonstrative acts in defense of the environment and our planet. They demand that science and the words of climate scientists be heard.

The first work of art was targeted with a cake and it was Leonardo da Vinci's Mona Lisa, housed at the Louvre Museum in Paris. At the National Gallery in the British capital, activists glued themselves to John Constable's painting The Hay Wain, causing minor damage to the artwork in this case. They then targeted the Botticelli Room at the Uffizi Gallery in Florence, where they hung a banner reading "Ultima generazione, No Gas No Carbon," before gluing themselves to Botticelli's painting "La Primavera."

In most cases, these are not demonstrative acts aimed at damaging works of art, but rather to destabilize, create discomfort, and provoke reactions to talk about such a delicate issue as climate change.

Activists have realized that art, for us, represents a weak point to provoke our reaction, as they are objects of inestimable value, created by artists who lived centuries ago.

1.1 Context

After observing these events, caused by representatives belonging to various movements that fight for climate change and above all to spread a warning message to the whole planet, we have noticed a strong growth in research regarding these events. We will analyze how these events have affected users of a social platform through the analysis of Twitter using the API (Application Programming Interfaces, that is the programming interfaces of the applications) provided by the company to determine if they have had a positive or negative impact on the general public.

The events considered for the analysis are crimes committed during the year of 2022 and the countries took in consideration for the analysis are: Italy, United Kingdom, France, Spain, and the United States.

In May, Louvre was targeted by a protester who threw a cake at the "Mona Lisa" of Leonardo Da Vinci.

In July, a series of English museums were targeted by Just Stop Oil, including the Courtauld Gallery in London, the Kelvingrove Art Gallery in Glasgow, the Manchester Art Gallery, and the National Gallery in the capital, where young activists glued themselves to a John Constable painting, causing minor damage.

In Italy, in July, a protest took place in the Botticelli room of the Uffizi Gallery in Florence, with activists gluing themselves to the glass protecting the painting of La Primavera. At the end of the month, Ultima Generazione activists attacked the Museo del '900 in Milan and glued themselves to the structure supporting Umberto Boccioni's sculpture Forme uniche della continuità nello spazio.

In October, they targeted Vincent Van Gogh's Sunflowers, kept in London, with tomato soup. Monet was also targeted by Ultima Generazione activists at the Barberini Museum in Germany.

On October 27, Vermeer's painting Girl with a Pearl Earring exhibited in the Mauritshuis Museum was hit. Two members of Futuro vegetal glued themselves to the frames of Francisco Goya's paintings at the Madrid museum.

Fortunately, these works were protected by glass, so all the paintings affected showed minor to no damage at all.

2. Motivation behind our research

Sentiment analysis regarding individuals who damage works of art is an important research for several reasons. Firstly, works of art are a cultural and historical heritage that represents a significant part of our identity and history. Damaging them is a crime that goes against our cultural and historical heritage. Secondly, sentiment analysis can provide useful information to prevent these acts of vandalism and protect works of art for future generations. For example, sentiment analysis can identify the feelings and opinions of individuals about the protection of works of art, and this information can be used to formulate more effective policies and improve public education. Additionally, sentiment analysis can help to understand the motivations behind vandalistic behavior and find solutions to prevent it. In summary, sentiment analysis regarding individuals who damage works of art is an important research to protect and preserve our cultural and historical heritage.

The motivation behind acts of vandalism that damage such important works must be equally important to them; in fact, the reason behind their actions is the spread of policies against environmental pollution and the prevention of such a crisis.

The climate crisis is a very current topic that will have an important impact on future generations but is not always at the center of discussions on online platforms, despite everyone knowing how critical the current situation is.

For psychological reasons, the problem of global warming is not often discussed even though we are aware of it.

According to psychologist Espen Stoknes, there are five reasons why the fight against climate change involves little people:

- The temporal and spatial distance of the negative consequences of climate change;
- Destiny, we perceive it as an inevitable thing;

- Dissonance between what we do every day and what we know we should do;
- Denial of the problem, which comes naturally to us when we do not want to feel responsible;
- Cultural identity and political values that in people with conservative orientation lead to rejection.

3. Queries

After carefully analyzing the situations, we posed ourselves some questions:

- Were these actions really necessary to attract the attention of the general public?
- Does committing crimes really have a positive impact on the masses?
- How can we help our planet for ourselves and future generations?
- How was this message perceived by users on the Twitter social platform?
- What are the feelings and opinions of individuals regarding the protection of artworks?
- What are the motivations behind vandalistic behavior?
- What policies can be implemented to protect artworks?

To answer these questions, a detailed analysis of the behavior of a large group of individuals within a platform is necessary, that is, carrying out sentimental analysis and deriving results from it. The analysis of the platform can offer important information and answers to certain questions, such as those we have previously stated. The collection and analysis of data on a platform, such as Twitter, can provide a vast amount of information on user behavior, opinions, and preferences. This information can be used to answer many questions. The analysis of the platform can provide answers to these questions and many others using techniques such as text mining, sentimental analysis, and network analysis.

These techniques can be used to analyze the data collected from the platform, such as tweets, and extract relevant information. Despite these limitations, the analysis of the platform can still provide valuable information and answers to questions. By using rigorous and appropriate methods, researchers can obtain

reliable and meaningful results that can be used to understand the attitudes of users belonging to a particular platform.

4. Data Analysis

Analysis is a process that involves examining and interpreting data or information to draw conclusions. The analysis process begins with collecting and organizing data, which can be in any format, in our case sentences or texts. Next, these data are processed using mathematical, statistical, or machine learning methods to identify patterns and trends. Finally, the obtained information is interpreted by creating graphical models that represent the data and relationships between them to formulate conclusions later.

For our analysis we needed to determine whether or not the actions of the protesters managed to change the opinion of the users inside the twitter social media platform, which wasn't an easy task to perform.

We aim to explore the attitudes and opinions of Twitter users towards the climate crisis, specifically in response to the actions of environmental movements.

Through this analysis we hope to understand the behaviour of the users and detect possible trends inside the network.

4.1 Data collection

The data has been collected through the SNScrape library suggested by our professor; since the API given to us is not able to search for tweets older than 7 days we had to scrape old tweets.

The collection was carried out in a matter of days, by scraping every tweet that could possibly be somehow related to the topic we were interested in, we needed to narrow down the numbers by searching for specific keywords and hashtags in order gather all the possible useful information for our analysis.

The data we collected was not random but we followed a criteria:

- 1- First we needed to decide which events to analyse

- 2- After finding the events we had to determine the day they took place
- 3- Collecting tweets using specific keywords and hashtags 15 days prior to the event and 15 days after

With this kind of data collection we can take a better look at how the users were talking about the interested topic before and after the event.

4.2 Analyzed events

The events we decided to analyze are the acts of vandalism that we discussed in the introduction of the report, which occurred during the year 2022.

The events considered for the social media analysis include:

- Trends: Keyword and phrase trends are one of the most important factors considered during social media analysis. These trends can provide information about users' opinions and preferences regarding certain topics.
- Sentiment: Sentiment is another important factor considered during social media analysis. This factor seeks to identify whether a tweet or post contains positive, negative, or neutral emotions, helping to understand users' viewpoints on a particular topic.
- Advertising campaigns: Social media advertising campaigns can have a significant impact on users' opinions. Social media analysis can help evaluate the effectiveness of these campaigns and understand whether they are achieving their goals.
- User interactions: Social media analysis can also consider user interactions, such as likes, comments, and shares. These interactions can provide information about users' level of engagement regarding a particular topic.

The 4 main events that we've analysed each took place in a different country based on their official language:

- 1- The incident occurred at Louvre in Paris: around the month of may in 2022 a climate activist disguised as an old lady on a wheelchair managed to snuck inside the museum with a cake and threw it on the Mona Lisa.
- 2- The incident occurred at the national gallery of art in London: two activists of the movement "Just Stop Oil" during the month of october 2022 entered

the national gallery of art in london and threw tomato soup on Van Gogh's Sunflowers and proceeded to glue themselves to the wall.

- 3- The incident occurred at the Uffizi gallery in Florence: three activists of the italian movement "Ultima Generazione" (Last Generation) entered the Uffizi's gallery during july 2022 and glue themselves on Botticelli's Primavera.
- 4- The incident occurred at the Prado's museum in Madrid: at the beginning of the month in november the environmental activist group Futuro Vegetal glue themselves to Francisco Goya's paintings, "The Clothed Maja" and "The Naked Maja" whilst writing "+ 1.5°C" on the wall.

The following paragraph contains the tools we used to gather information:

PARIS LOUVRE MUSEUM: activist disguised as old woman throws a cake at the painting, 29th may 2022

- Keywords used: attivisti, climate activist, just stop oil, mona lisa, mona lisa cake, ultima generazione, last generation
- Hashtag searched: #Louvre, #MonaLisa
- Account analyzed: @JustStop_Oil
- Total data retrieved: 559MB

LONDON NATIONAL GALLERY OF ART: Activists throw soup and glue themselves to the wall, 14th october 2022

- Keywords used: Attivisti, just stop oil, van gogh, national gallery of art, climate activists, last generation
- Hashtag searched: #VanGogh, #NationalGalleryOfArt
- Account analyzed: @JustStop_Oil, @ngadc
- Total data retrieved: 1.14GB

ITALY UFFIZI GALLERY : Activists glue themselves on the paintings, 22nd july 2022

- Keywords used: attivisti, ultima generazione, uffizi, just stop oil, climate activist, botticelli
- Hashtag searched: #Uffizi, #Botticelli
- Account analyzed: @JustStop_Oil, @UffiziGalleries, @UltimaGenerazi1
- Total data retrieved: 355MB

SPAIN PADRO MUSEUM: activists glue themselves on the paintings after writing down +1,5°C on the wall, 05th november 2022

- Keywords used: climate activist, last generation, just stop oil, prado museum, just stop oil, attivisti, francisco goya, activistas
- Hashtag searched: #franciscogoya, #pradomuseum
- Account analyzed: @museodelprado, @JustStop_Oil, @FuturoVegetal
- Total data retrieved: 3.67GB

4.3 Data elaboration

For each analysed event we've used a set of keywords and hashtags to reduce the unnecessary data we've collected; avoiding data noise its quite impossible to accomplish so even after using specific keywords we had to further filter the dataframe.

The total amount of data collected is around 5.7GB which is a great amount that will need further filtering in order to avoid irrelevant data.

After creating different dataframes using keywords and hashtags we merged all the .csv files into a single one, for each event there will be a dataframe containing all the data 15 day before the event and another one containing all the data 15 days after the event.

From the file we defined different functions on python in order to elaborate the sentiment of the tweets by analysing their text with a python library called Vader that uses an algorithm to estimate the emotion of each user based on the raw content of the tweet; we decided to use Vader over TextBlob because after some research we found out that in terms of accuracy Vader is slightly more reliable than TextBlob.

But how can we understand the emotion of a user from different tweets?

There were 2 ways to analyse if a users changed their opinion after the event:

- Analyse only two tweets per users, which are the ones closer to the event
- Gather all the tweets for each user and determine the most relevant emotion (MRE)

We decided to rather use the second option than the first one because it's not really reliable to base the sentiment analysis on a single tweet before and after the event.

After creating the necessary dataframes the only thing left to do is compare the same users from before and after and observe if there was a change in their behaviour on the platform and their opinion.

4.4 Sentiment Analysis

As mentioned in the previous paragraph the collected data has gone through a sentiment analysis.

What is a sentiment analysis?

Sentiment analysis is a type of natural language processing (NLP) technique used to identify and extract subjective information from text data. It involves analyzing the text to determine the emotional tone, attitude, or opinion expressed in it.

In the context of our research, we have decided to use sentiment analysis to analyze the opinions and attitudes expressed in the text data we have collected. This analysis will help us gain insights into the emotions and opinions of the people who have provided the data and identify any patterns or trends that may be present. By using sentiment analysis, we hope to gain a deeper understanding of the data and draw meaningful conclusions from it.

Through the results we managed to acquire from this process we can estimate the percentage of each emotion per event and observe how the behaviour and opinion of user have changed based on the events.

What needs to be taken into consideration is the possibility of sarcasm and irony from some users being in the dataset that the algorithm might have confused for real opinions and thus assigning them the wrong emotion.

4.5 Data visualization

All the data elaboration will be visualised in the following chapter which will also contain all the details regarding every event; for each event there will be a further analysis that works with tweets of users who used the official language of the country where the incident took place in order to observe if there were any kind of bias due to the different culture and population.

An important factor that needs to be taken into consideration is the possibility of sarcasm and irony being within the analysed which can be very difficult for NLP algorithms to detect, depending on the algorithm used sarcasm can be identified as a neutral emotion rather than what it actually meant.

We also used gephi, a software that creates networks from an input file (.csv in our case), for the biggest network.

4.5.1 Louvre, Paris

This incident happened in the middle of the year 2022 where a man entered the Louvre museum disguised as an old woman in a wheelchair holding a cake which will be later thrown at the painting. The perpetrator, who didn't seem to be affiliated with any environmental movement, was seen wearing a wig and lipstick, and urged people to "think of the Earth" while being led from the scene. The security managed to take away the 36-year-old man, who was then sent to a police psychiatric unit in Paris. The security managed to take away the 36-year-old man who was sent to a police psychiatric unit in Paris.

This incident was widely spread throughout social medias since the targeted painting is famous worldwide thus causing a lot of people to talk about it and expressing their own personal opinion about it.

The incident happened the day 29th of may the year 2022, we will gather all the data 15 days prior and 15 days after.

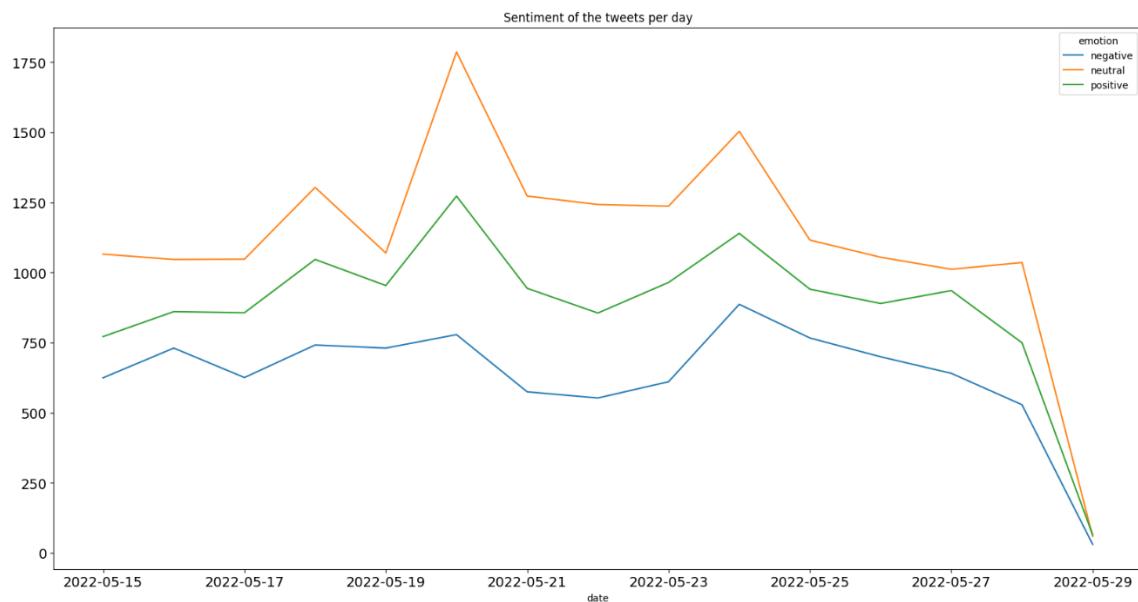
The before period will go from the 15th of may all the way to the day of the incident while the after period will go from that said day until the 14th of june.

As mentioned earlier the process analysis consists of sentiment analysis which helps us understand and view user's opinion using Vader on Python.

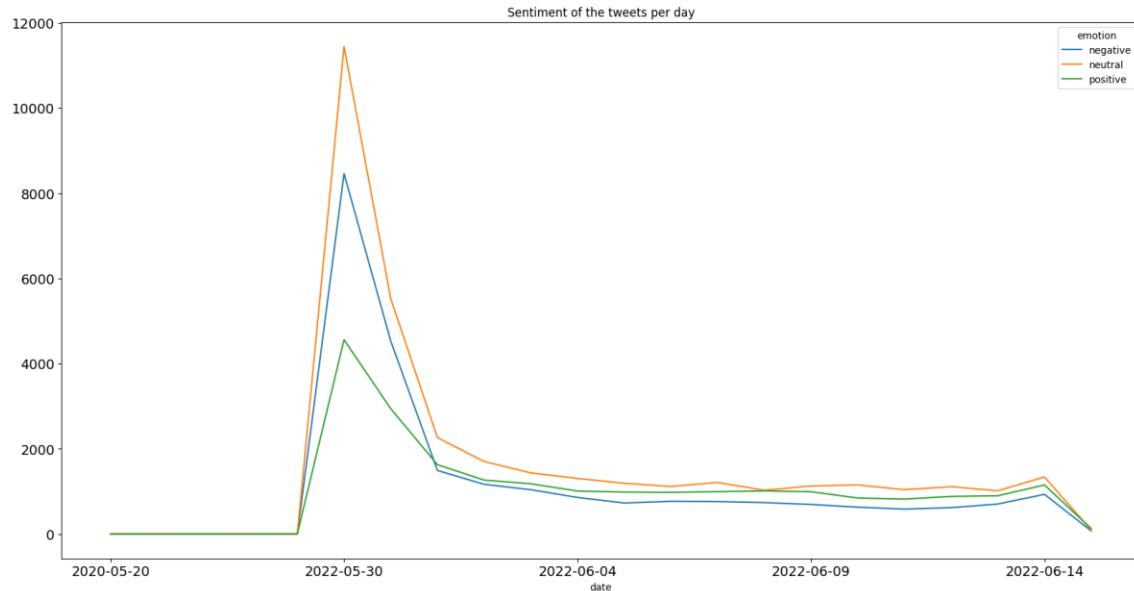
We decided to use Vader rather than TextBlob because according to some websites and tests vader seems to be slightly more accurate in terms of sentiment accuracy and it also takes capitalization, repeated words and emojis into consideration.

VADER (Valence Aware Dictionary and Sentiment Reasoner) is a lexicon and rule-based sentiment analysis tool that is specifically attuned to sentiments expressed in social media, and works well on texts from other domains. Thanks to this tool we managed to generate the following line charts:

Before period:



After period:

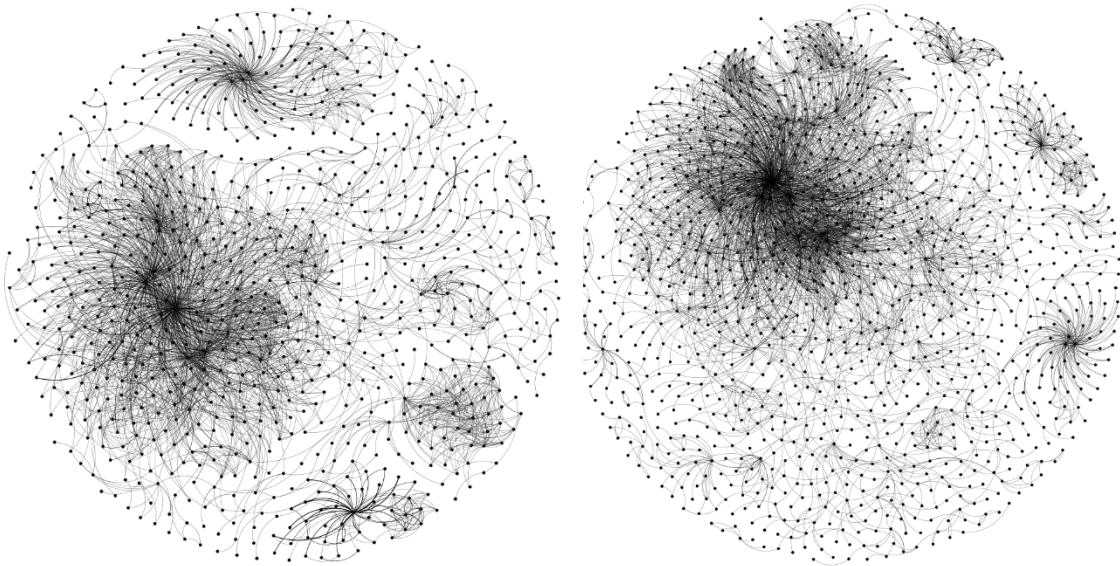


From the previous 2 multi-line chart we can observe how users talked about this topic mostly after it happened and only for a few days, this is mostly due to the recency bias which we will be seeing a lot in our research.

Recency bias is a cognitive bias that occurs when people tend to give more weight to recent events or information, rather than taking into account the overall situation which can affect the judgement of users.

Another cognitive bias that might have also taken part to the sudden increase of tweets regarding this specific topic is the Primacy Bias which occurs when people tend to give more weight to information or experiences that they first encountered rather than analysing the whole picture.

Here below we can see the overall mention network of the users in the before period (every node has a degree centrality higher than 5) :



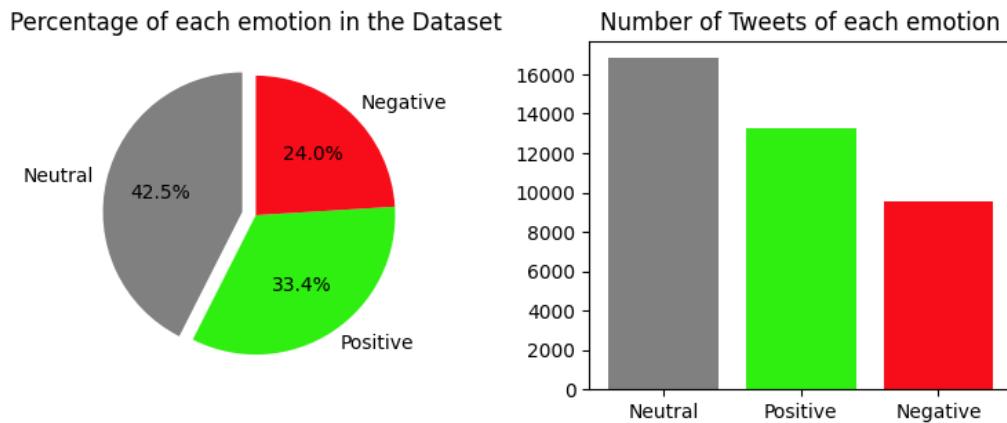
From this graph we can see various clusters connected to eachother which means that there are no significant echo-chambers inside this mention network.

Despite being two mention-networks from different time periods there isn't any significant difference between the connections or the graph, from this data visualization we cannot determine the behaviour of the users.

An echo chamber in a social network refers to a situation where users engage primarily with people who share similar views, beliefs, and values as themselves. In such a situation, the users tend to hear only opinions that reinforce their existing views, and their own opinions are reinforced by a positive feedback they receive from other users inside the echo-chamber making them narrow-minded.

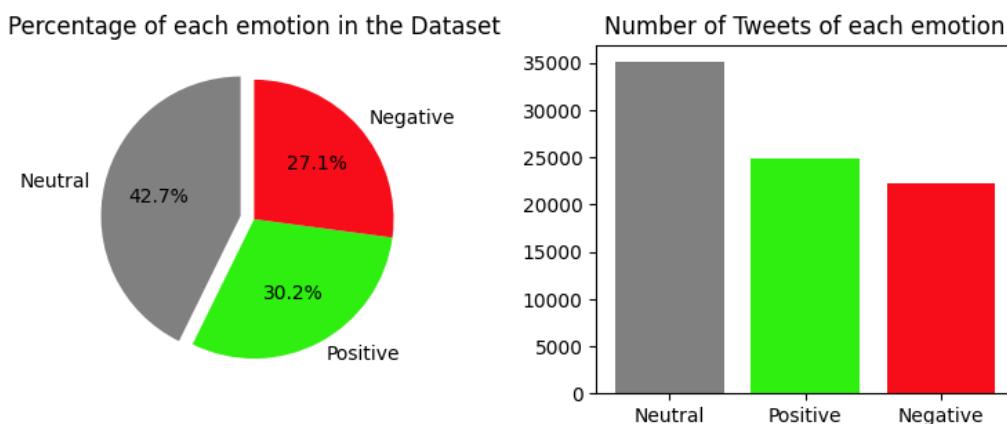
A simple network with no attributes as seen above only shows if there are clusters and echo-chambers, it doesn't really help us in understanding the behaviour and trends inside the network; through VADER and a function I've written on Python we managed to get the following data:

Sentiment analysis of tweets before the event



The image above shows the percentage of each emotion and their respective number of tweets inside the dataframe, we can see that the most relevant one is the neutral, followed by the positive emotions and then negative ones.

Sentiment analysis of tweets after the event

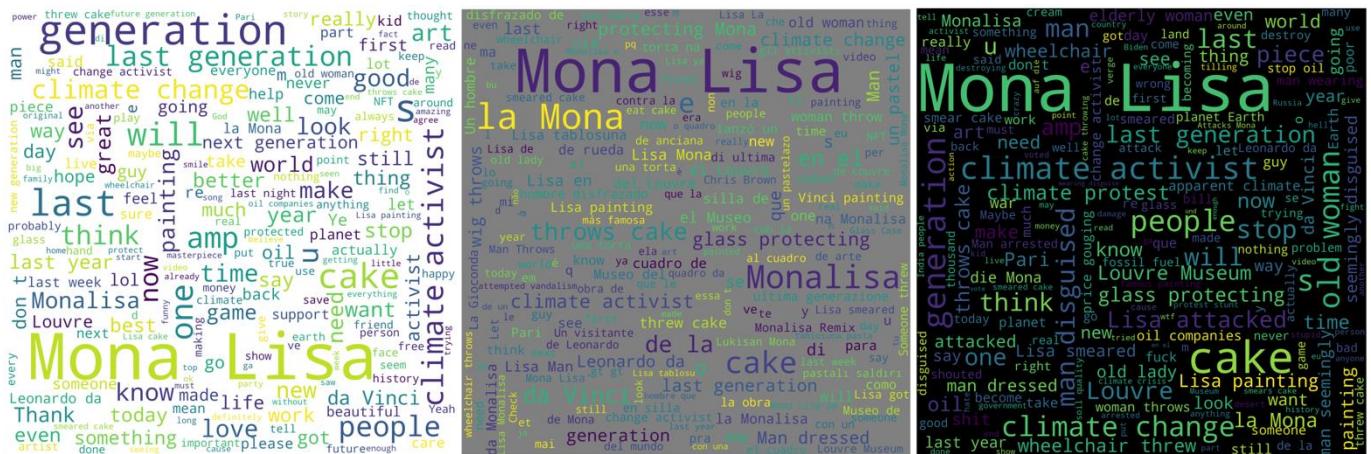


Here below we can see different wordclouds representing positive, neutral and negative emotion:

Before period



After period

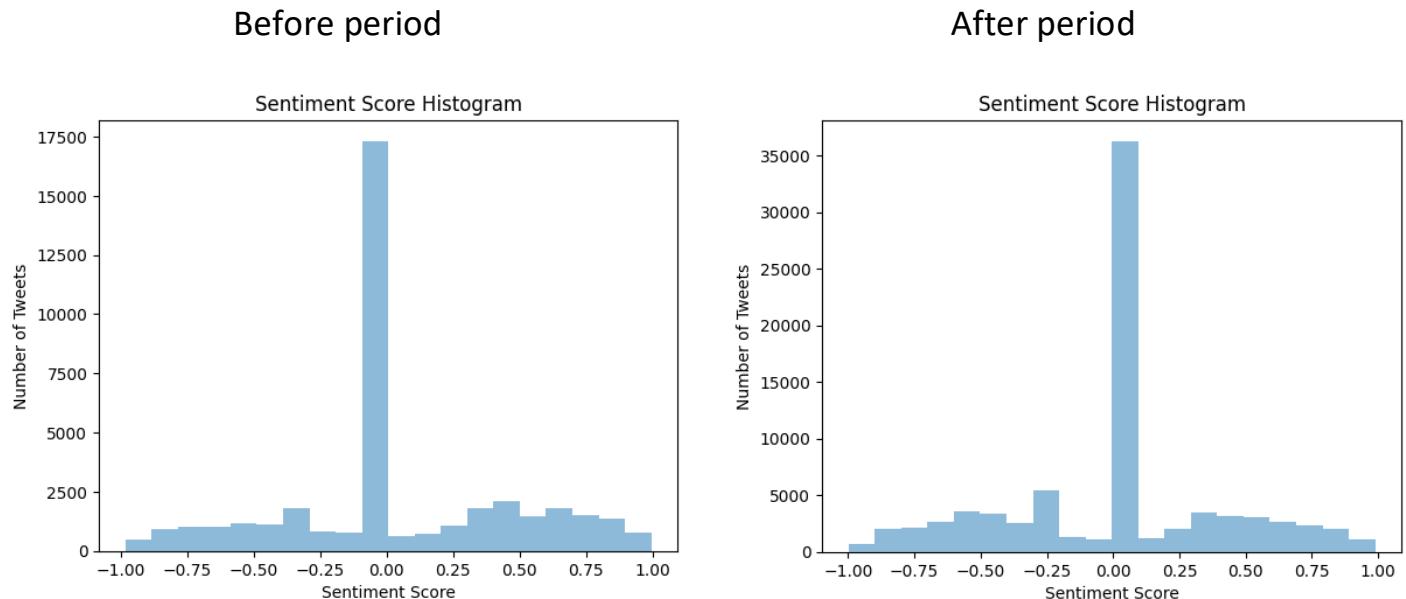


Each wordcloud obviously contains the keywords used for the data collection but we can also see for example other words like “love”, “better”, “hope”, etc.. in the positive wordcloud meaning that despite everything it had different effects on different people.

From what we can see so far the perception of the incident has been mostly neutral and positive, mostly probably because the painting wasn't damaged at all thanks to the glass protecting it, this might be another important factor that caused this neutral view on the situation.

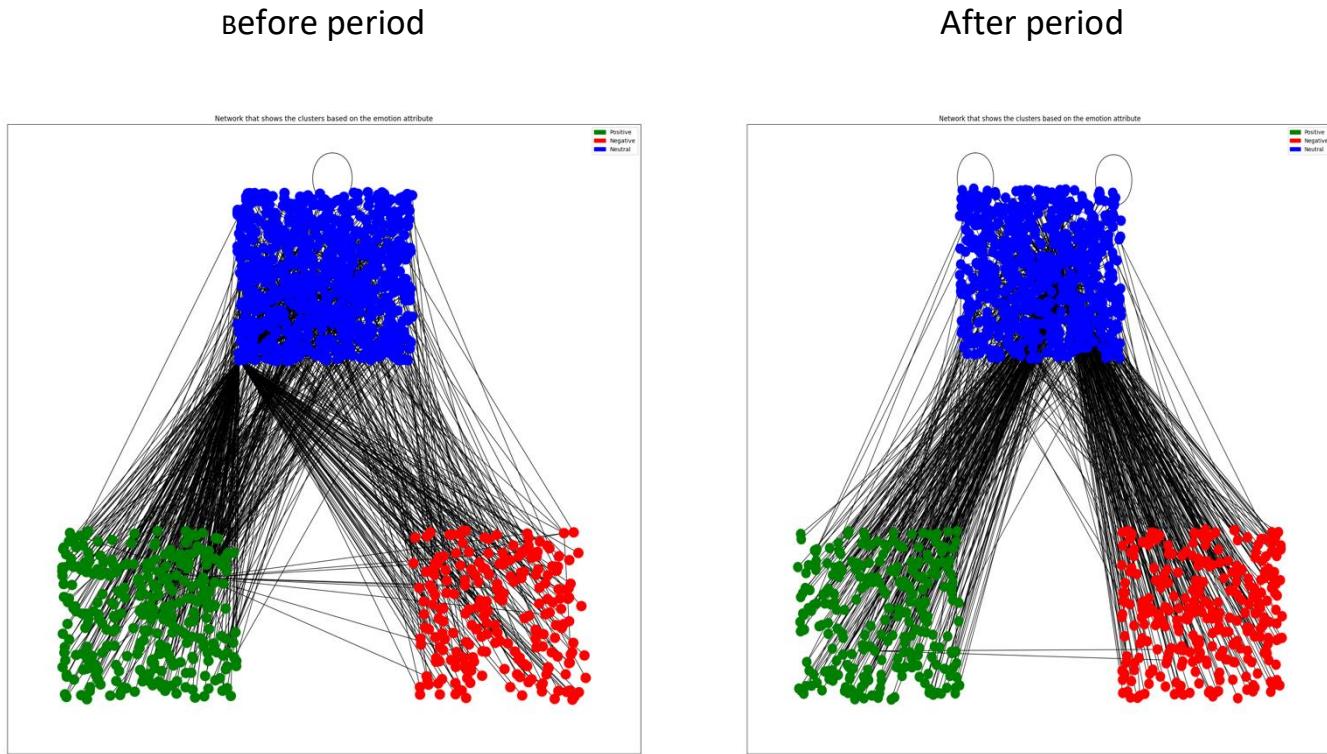
The VADER algorithm doesn't only return the emotion but also an index that indicates the polarity of a text that goes from -1 to 1; a score below 0 means negative while a score above means positive, meanwhile a score that is approximately close to the value of 0 means a neutral sentiment.

Here below we can see the highest sentiment score for each period:



We can notice how many tweets have been detected as neutral with a sentiment score of 0 which will be very common throughout all the events, therefore it is unnecessary to keep displaying which sentiment score was the most relevant in the dataset.

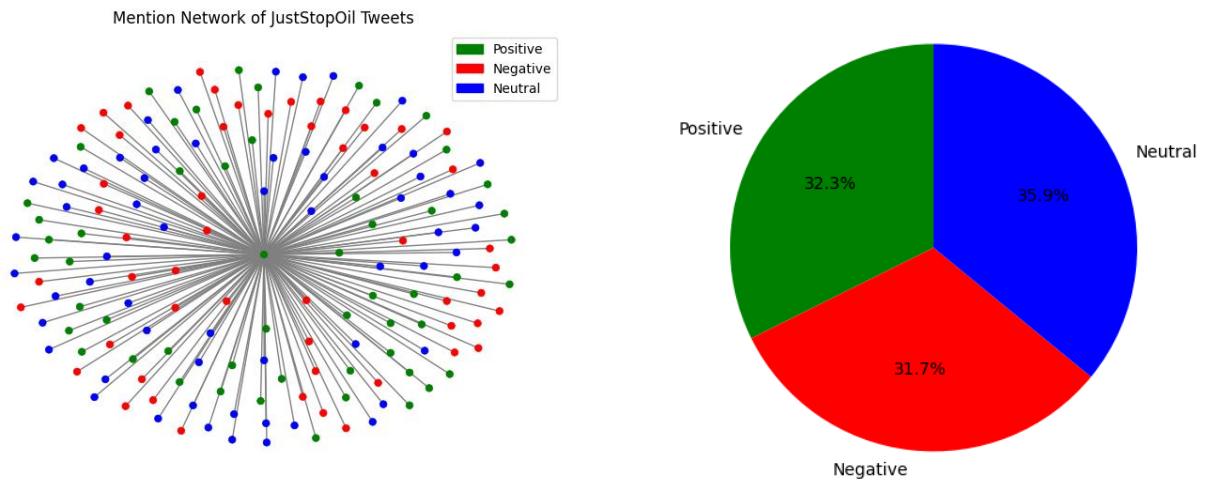
After estimating the sentiments of the users we decided to create from a subset of the dataframe a mention network manually clustered by their emotion in order to see the amount of connections between different clusters.



In these 2 mention network graphs that were manually clustered by their emotion attribute we can observe how there are very few connections between the negative cluster and the positive cluster, that possibly being users replying to only accounts that tweeted the information such as news accounts.

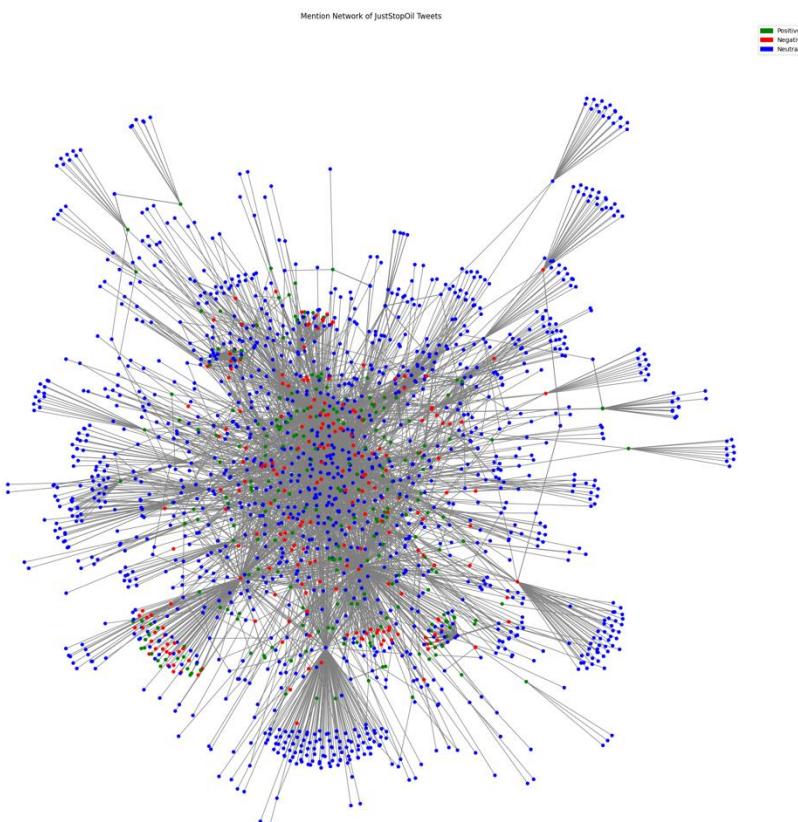
In this specific instance the climate activist wasn't part of any environmental movement but we still decided to analyze the mentions of a specific account which is Just Stop Oil, a british movement that seems to retweet and like any kind of event regarding the climate crisis.

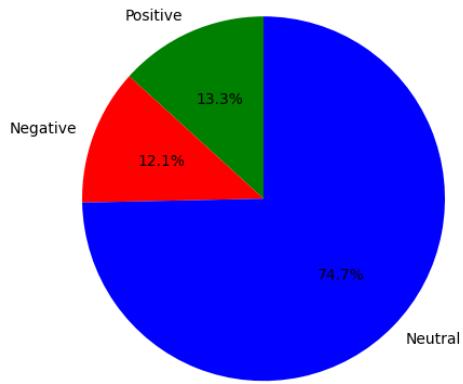
Mention network followed by the percentage of each emotion before the event:



There isn't a significant discrepancy between the emotions of the users during the period before the event.

Mention network followed by the percentage of each emotion after the event has occurred:

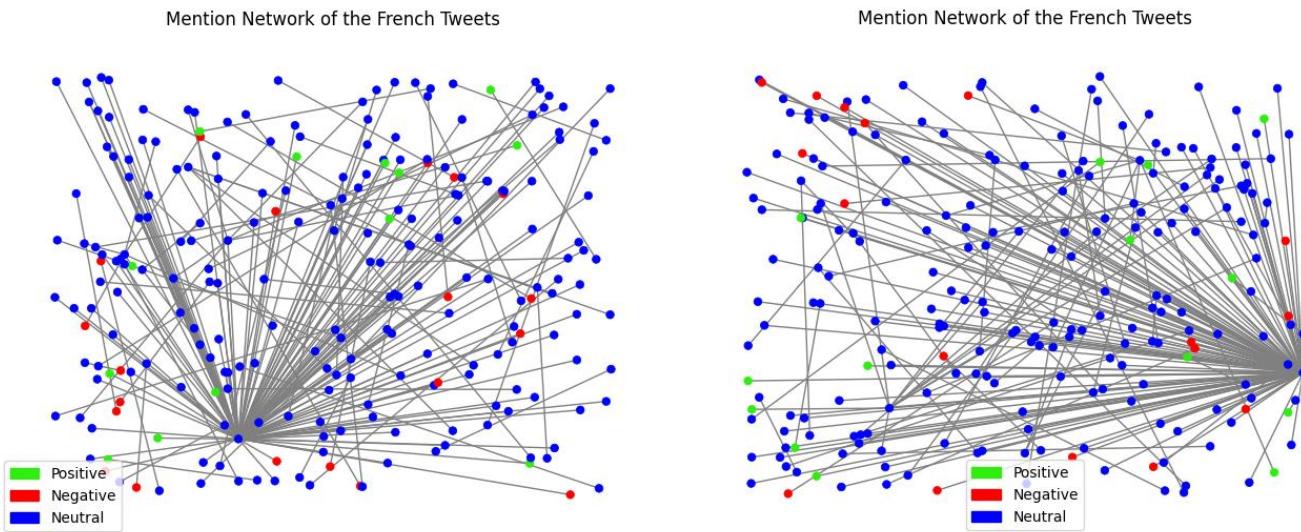




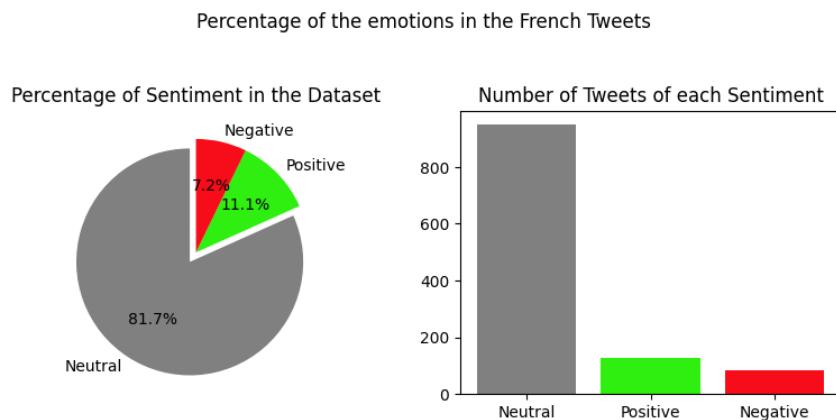
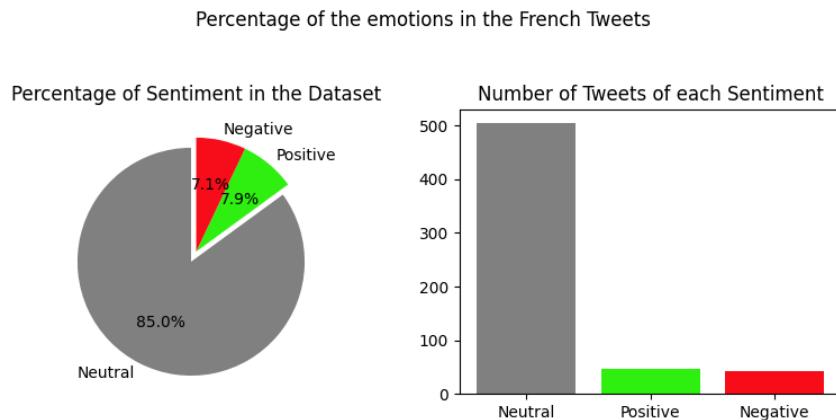
Compared to the tweets mentioning the account JustStop_Oil during the period before the event we can see that the number of users has increased significantly and the neutral emotion is way more prominent than before, this might be caused by jokes, sarcasm and memes on the internet which are very difficult for NLP algorithms to detect.

After finishing the previous analysis we took in consideration the french tweets in order to analyze only users who might be french or living in France by creating a new dataframe containing only the tweets in French which is the official language of the country.

This was done in order to see how the french population viewed this incident and determine whether or not the demographic bias due to the different culture has an important role in people's opinions.



The above mention networks show respectively the before and after period and from what we can see there is the large amount of neutral emotions.



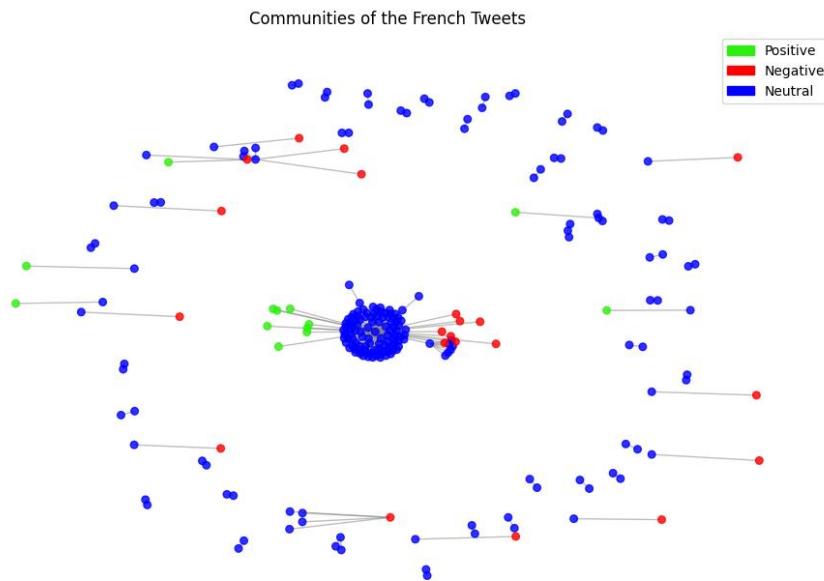
As we can see in both periods the most common emotion shared by the users is neutral.

Rather than analysing the whole network as a big community we used the Girvan-Newman algorithm to detect the communities inside the network.

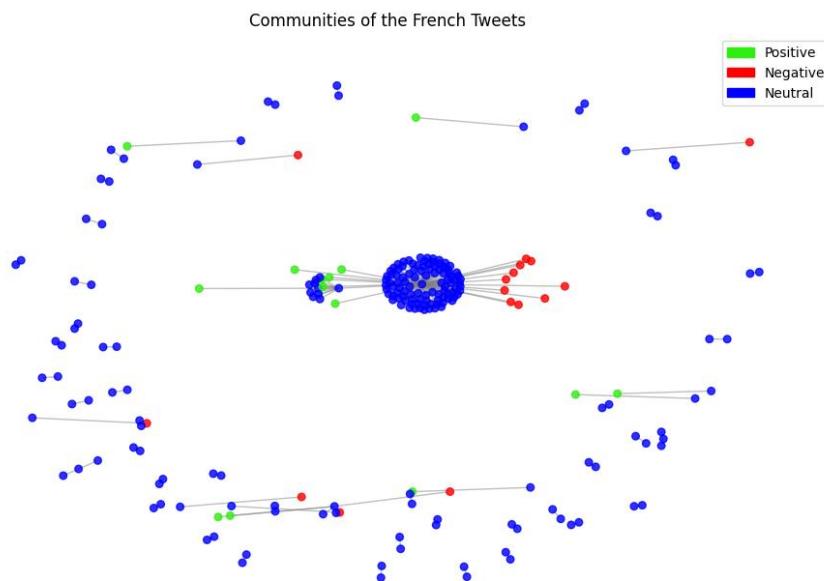
The Girvan-Newman algorithm is a community detection algorithm used in network analysis. It is based on the idea of betweenness centrality, which measures how often a node lies on the shortest path between two other nodes in the network. The algorithm works by iteratively removing edges with high betweenness centrality, which breaks the network into smaller components or clusters.

By removing these bridges that connect different clusters and sampling the data down to only 200 users we managed to get the following networks of communities:

Before period



After period

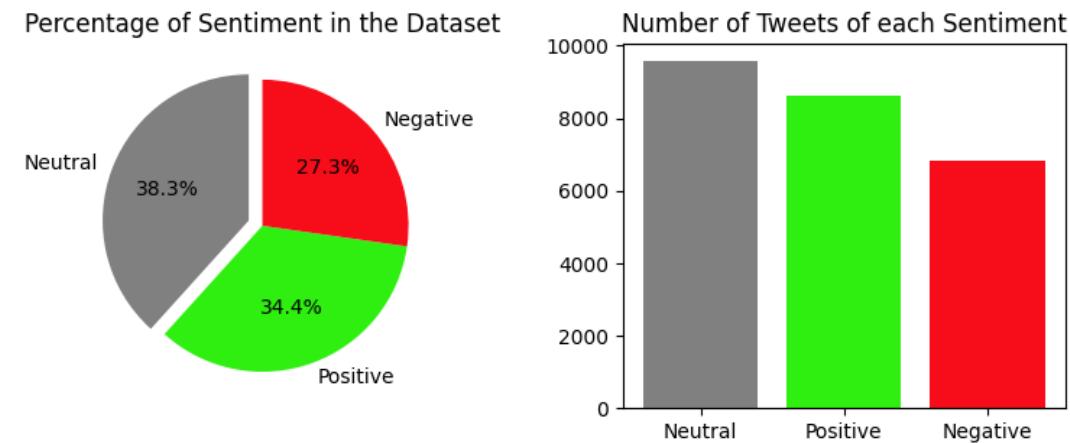


Most of the communities that were detected by the Girvan-Newman algorithm seem to be small ones and composed by only neutral node, meaning the

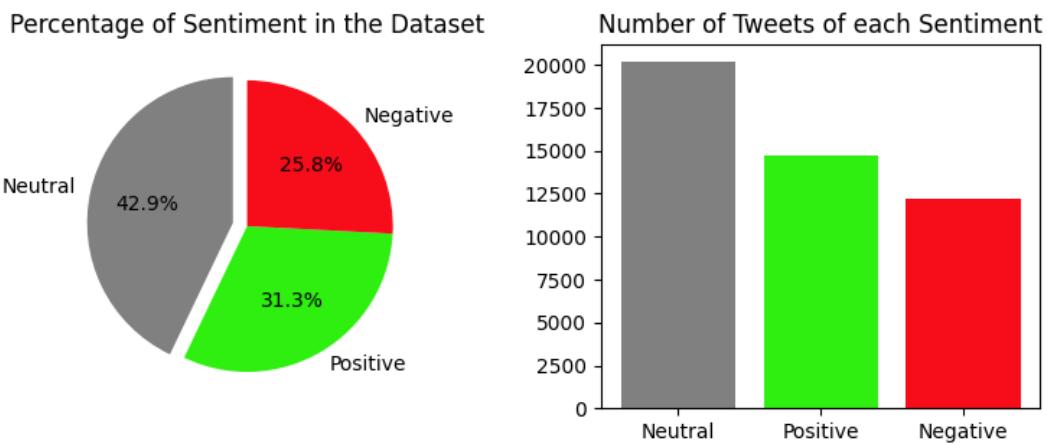
existence of echo-chambers inside the graph; the biggest community at the center are mostly neutral but with some connection to other kinds of emotions, that probably being a citation network of different news accounts and users replying to those tweets.

To determine who changed sentiment after the event we first need to create a new dataframe that removes duplicated users and group them by creating a list of emotions for each user, this way we can determine the most relevant emotion per user (MRE function) and created the following charts:

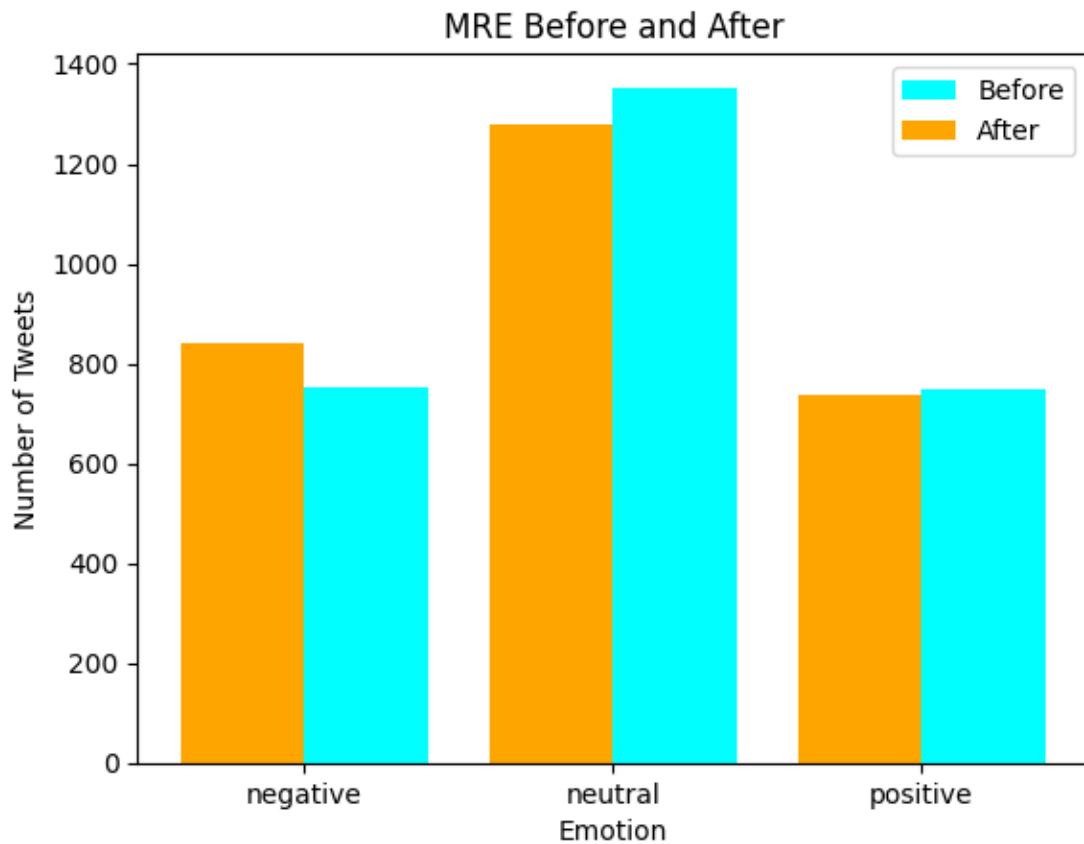
Percentage of the Most Relevant Emotion per User



Percentage of the Most Relevant Emotion per User



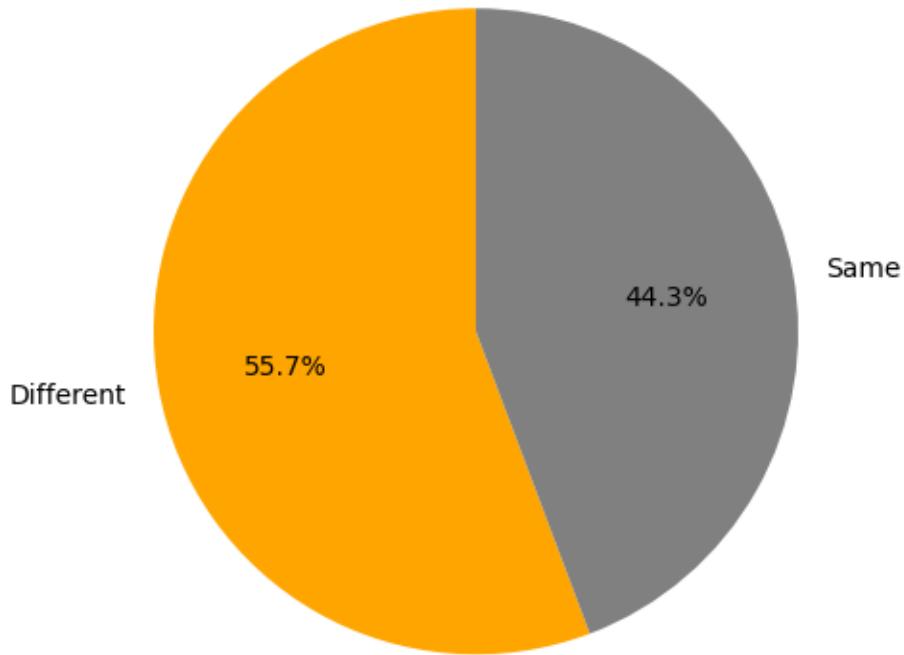
Our analysis might not be accurate since understanding the opinion of someone towards something that hasn't happened yet is very difficult, at this we can just assume through the analysis of our incomplete dataset.



If we compare the two analysis we can see that there aren't any huge differences in numbers per emotions but that doesn't necessarily mean that the same people had the same emotion throughout the analysis.

After comparing the two MRE's dataframes of the different period we needed to find out how many users changed their opinion by creating a new dataframe containing the same users and analyzing who changed and from what emotion.

Here below we can see a pie chart that represents the percentage of people that had a different overall opinion before and after.



More than half of the users had a different opinion after the event and from the dataframe we created earlier we managed to find:

- Most common emotion switched from :
By finding the most common emotion after and from that finding the most common emotion before
- Most common emotion switched to :
Same criteria as the most emotion switched from but swapping the

The most common emotion switched from is the ‘negative’ while the most common emotion switched to is ‘neutral’.

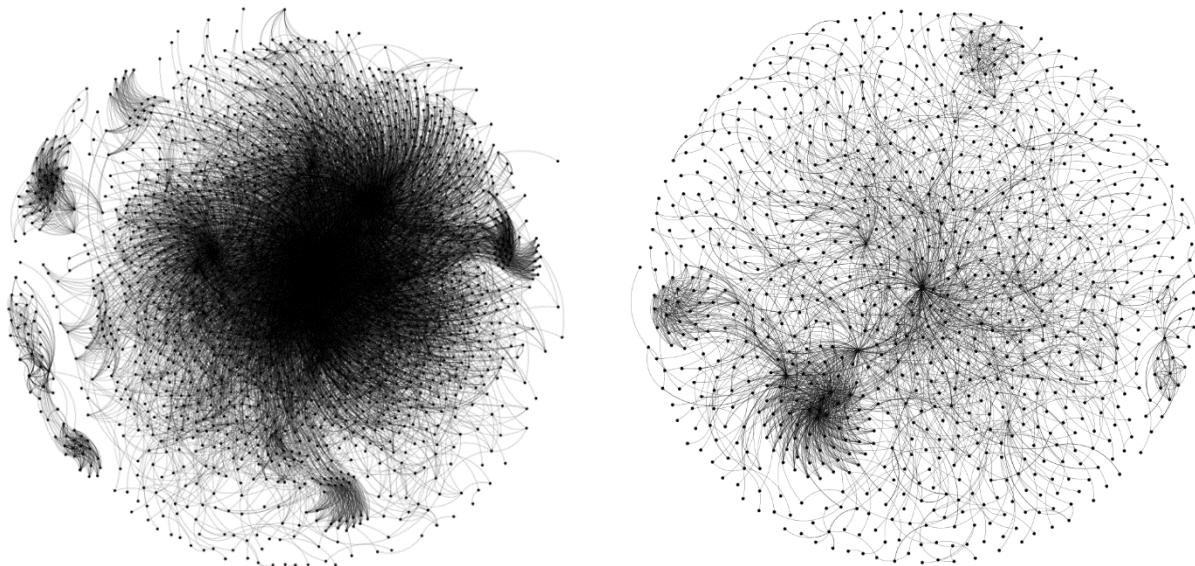
4.5.2 National Gallery of Art, London

During the month of October 2022 two activists, who are part of the climate change-focused group Just Stop Oil, threw tomato soup on van Gogh's Sunflowers, an important example of the Post-Impressionist's style and one of the National Gallery's many treasures. Then the activists glued themselves to the wall under the painting.

The gesture is one that Just Stop Oil has regularly done in the U.K., where its young members have repeatedly sought to push the government to respond more quickly to the destruction of the natural environment. Their tactics have often involved gluing themselves to artworks, usually without any damage to the pieces themselves, and their protests have inspired similar ones in Italy and Australia.

The same analysis process will be performed on all the events.

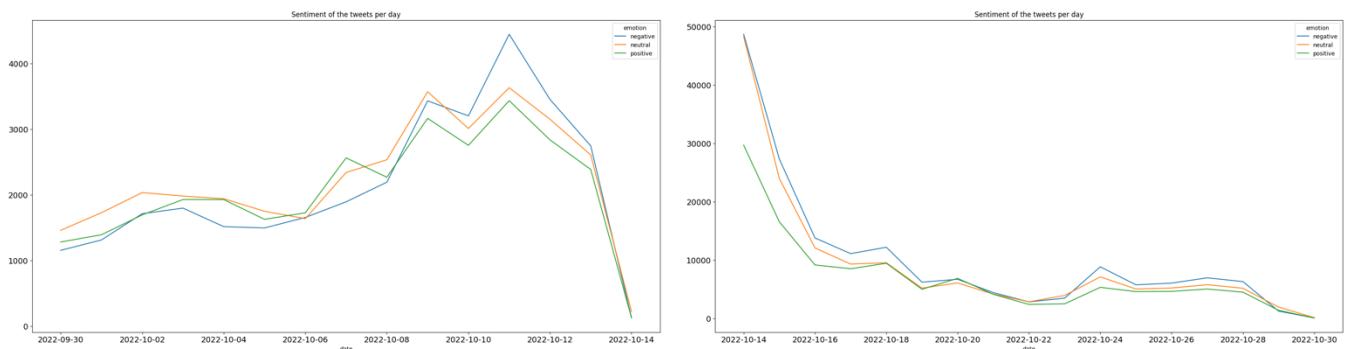
We will first view a simple mention graph to get a general view of the network we're working with:



Both of the mention networks above were filtered to show only nodes with a degree centrality above 5, but for some reason some nodes seem to be lower. Despite the same filter, the network from the period before has more nodes and way more connections.

First of all we can notice how much different the graph is from the previous event by comparing the amount of nodes in the network and how they are all clustered towards the center.

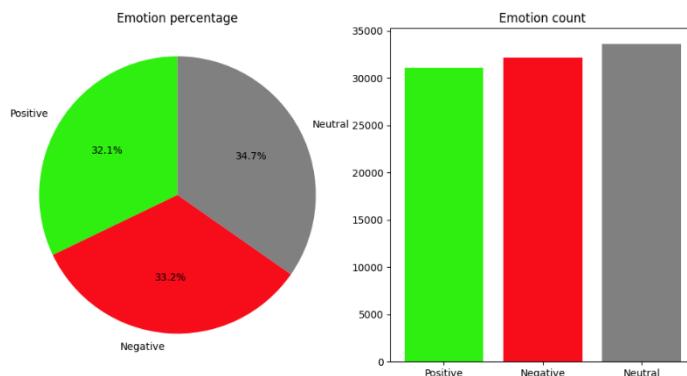
Here below a multi-linechart wil display the amount of tweets of each emotion per day during the 2 periods analyzed:



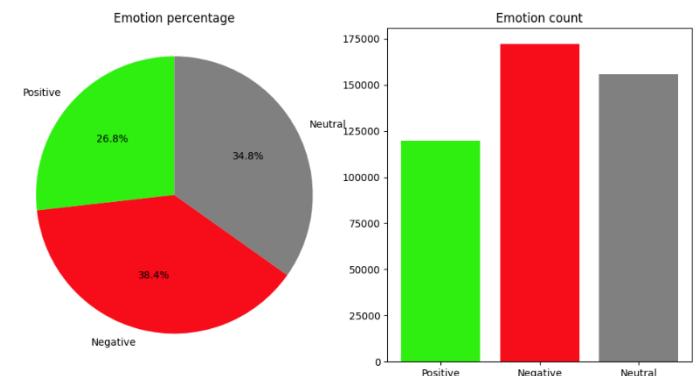
As said before there are some kind of bia

The dataset we're currently working with is way bigger than the previous one.

Before

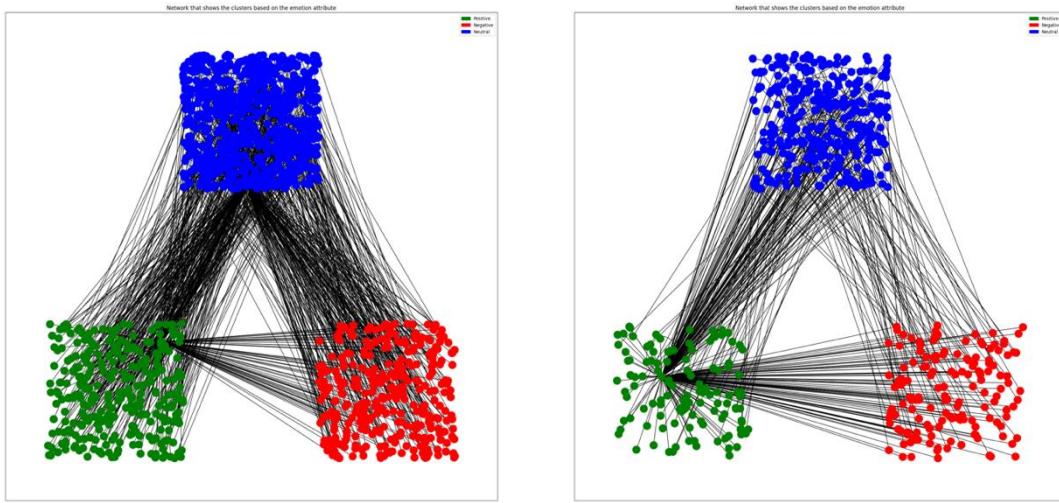


After



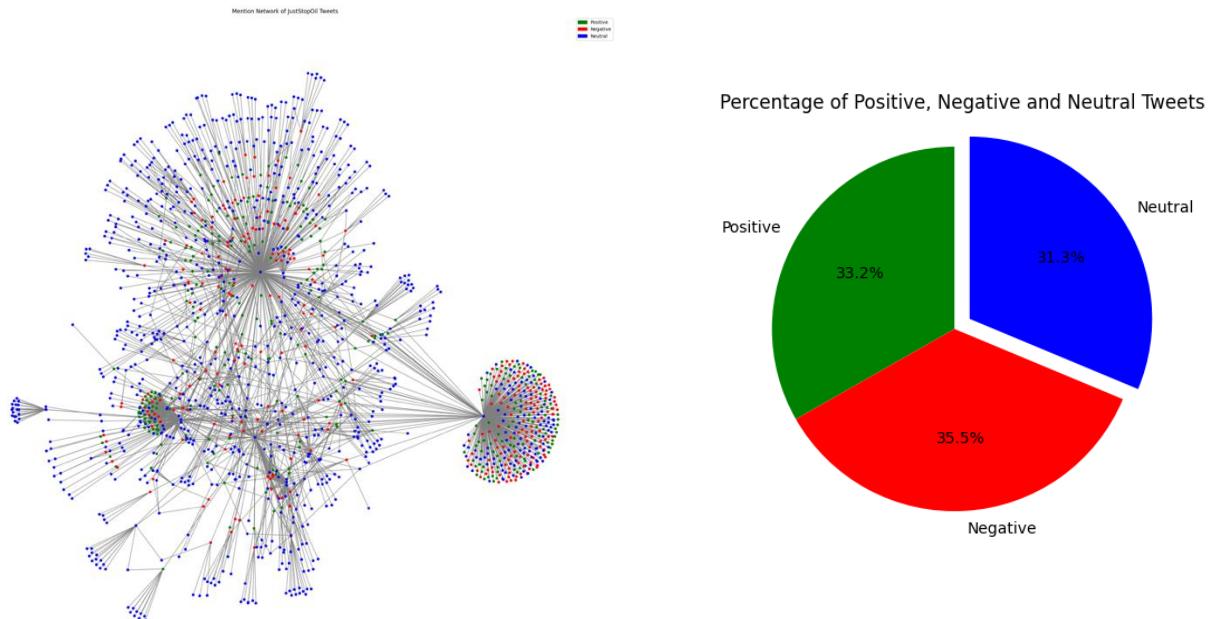
Firs thing we can notice by comparing the chart from before and after is a slight increase in the number of negative emotions towards our topic of interest, which is different from what we've seen before where the amount of neutral emotions were almost twice as much as the others.

Now let's compare the clusters of emotions and determine how many connection they have with eachother.

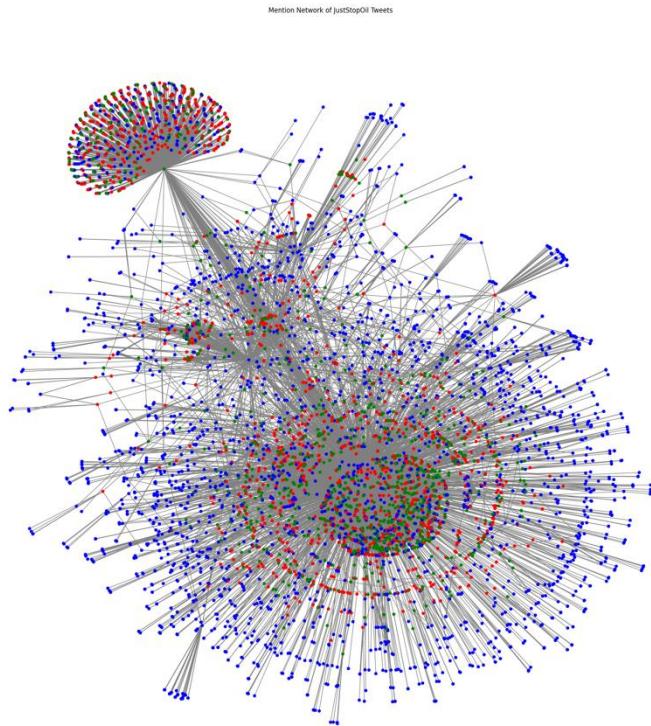


There isn't a huge difference in the two networks above and as we can see the negative and positive clusters always share less bridges with eachother than with the neutral cluster.

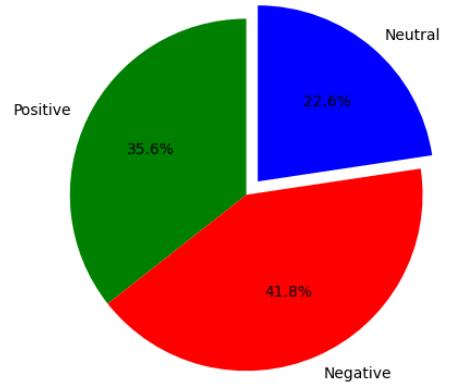
The two activists were part of the environmental movement Just Stop Oil that we mentioned earlier therefore we will also analyze the emotions towards the official twitter account.



Before the incident the emotions were mixed but we can already see an increase on the size of the network meaning the movement gained more attention overtime due to other similar occurrences throughout the world.

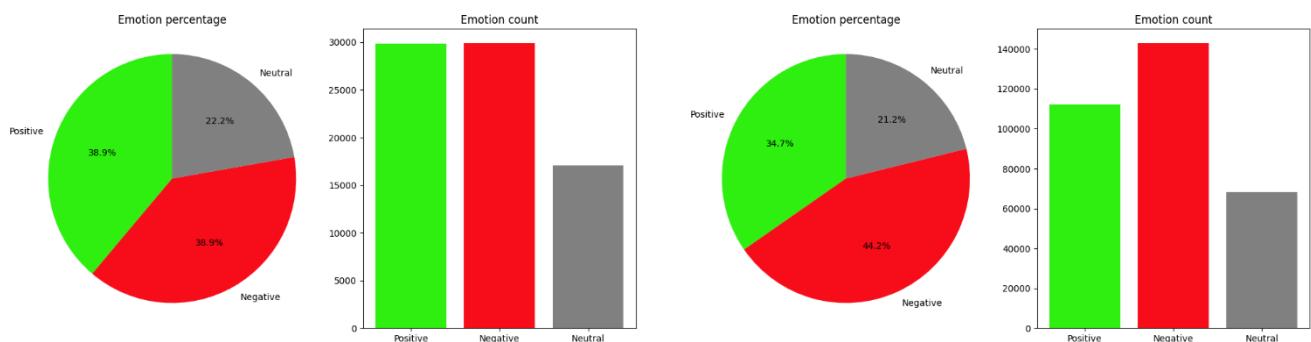


Percentage of Positive, Negative and Neutral Tweets



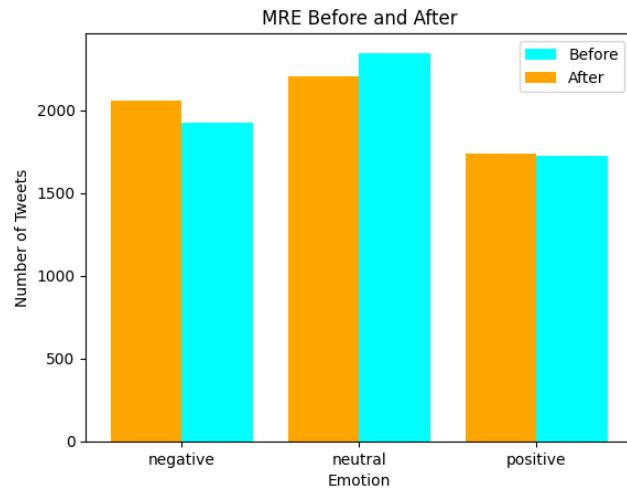
The most noticeable difference afterwards is the size increase of the network and the overall negative sentiment of the public towards the movement.

We will now narrow down the number of users we're working with to see how the local people's opinions were.



It seems like the locals already had a negative sentiment towards the movement and the action didn't leave the desired effect on the people.

Did the two protesters manage to change the opinion of the public?



The MRE returned these results, as shown the most shared emotion of users who tweeted both before and after is the neutral, that doesn't necessarily mean that most people didn't change mind, in fact:

- 66.8% of the users had a different opinion afterwards
- 33.2% remained the same

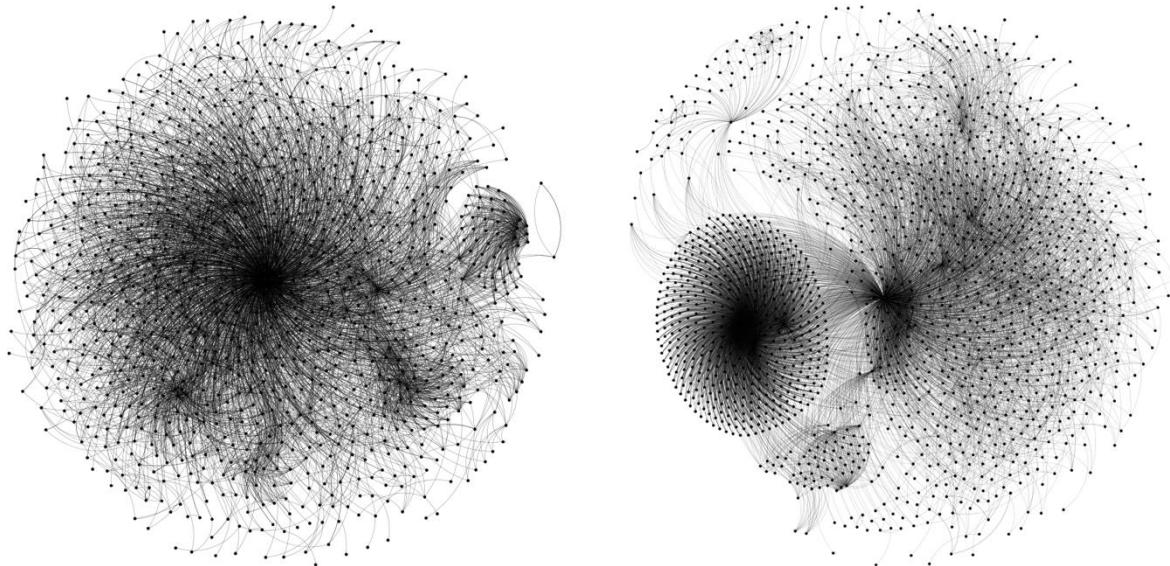
The most common emotion switched from is neutral which coincidentally is also the most common emotion switched to.

4.5.3 Prado's Museum, Madrid

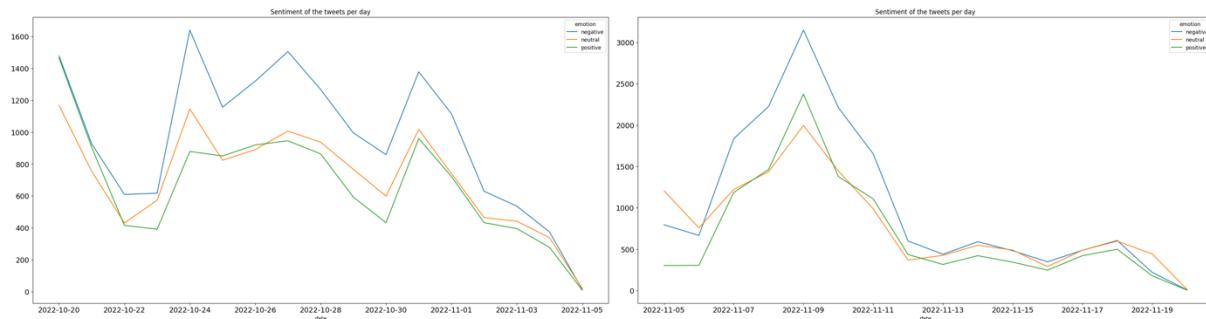
At the beginning of the month of November protestors from Spanish environmental activist group Futuro Vegetal glued themselves to Francisco Goya's paintings The Clothed Maja and The Naked Maja, which hang in Madrid's Prado Museum, and wrote "1.5 C" on the wall next to the painting.

By using different keywords we managed to gather an incredible amount of information which was really hard to work with and visualize, so we decided to work with a sample of the original dataframe and created a subset of 40 thousands random rows to analyze, which might not return the same result as it should from the original dataset and it also might contain unnecessary tweets from other topics.

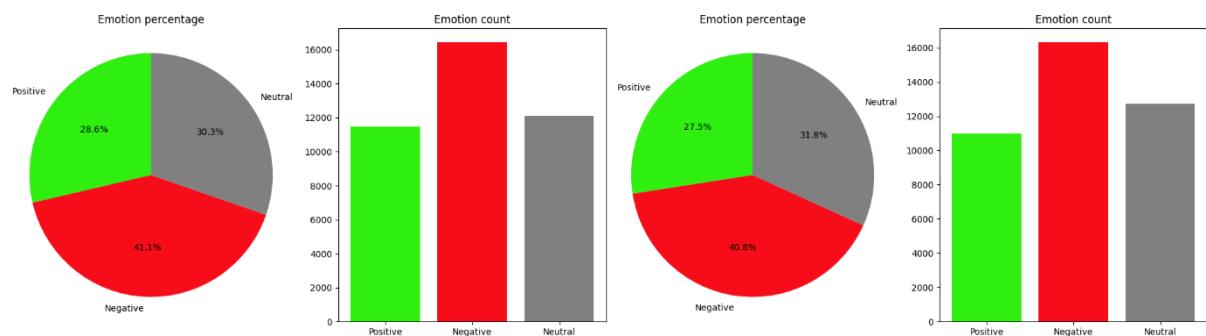
Despite narrowing down the number of tweets the overall network resulted to be quite big to work with, therefore both of the networks below have been filtered to show only nodes with a degree centrality above 10



By comparing the mention graph from the two time periods we can notice an astounding change in the cluster of the nodes, in the after period there is a noticeable cluster on the left with some users at the center who might be journalists or some other kind of public figure.



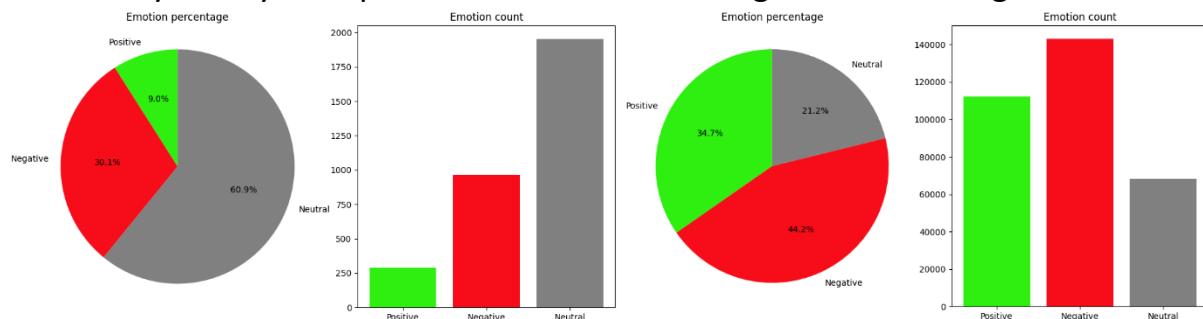
As usual from the multi-line chart above we can see the sudden spike in tweets regarding the topic a few days before the incident.



By comparing the amount of sentiments shared by the users inside the platform there doesn't seem to be a significant change, the overall opinion of the public regarding the environmental activist is mostly negative.

As shown on the analysis earlier, on the network clustered by emotion there are always less bridges between the positive and the negative clusters.

If we analyze only the Spanish tweets instead we get the following:

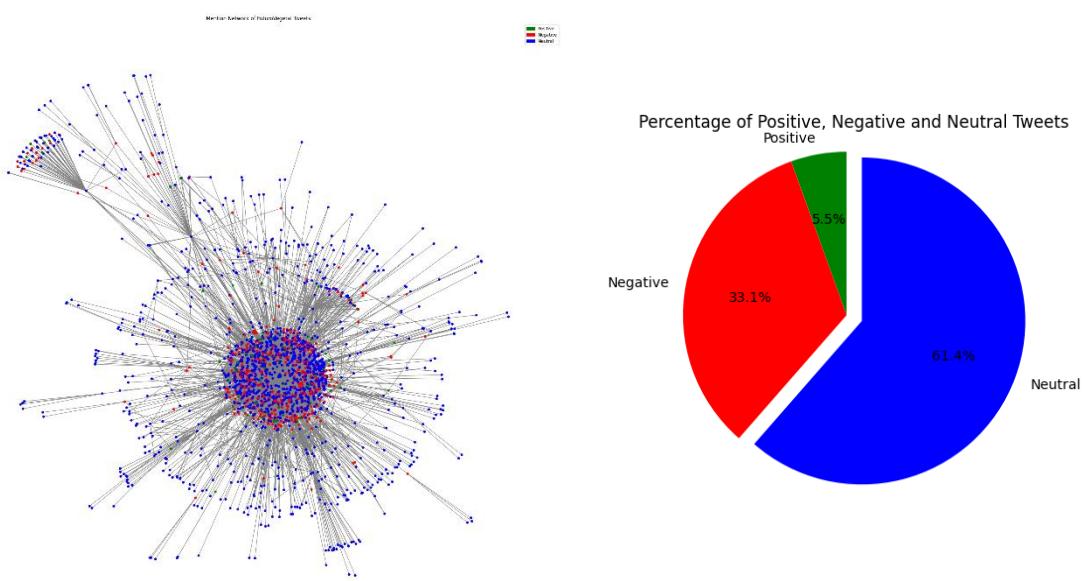


We can notice an astounding change in the feedback of the locals towards the topic.

The two activists were part of the environmental movement Futuro Vegetal, now let's take a closer look at how the mention network and emotions were towards this movement.

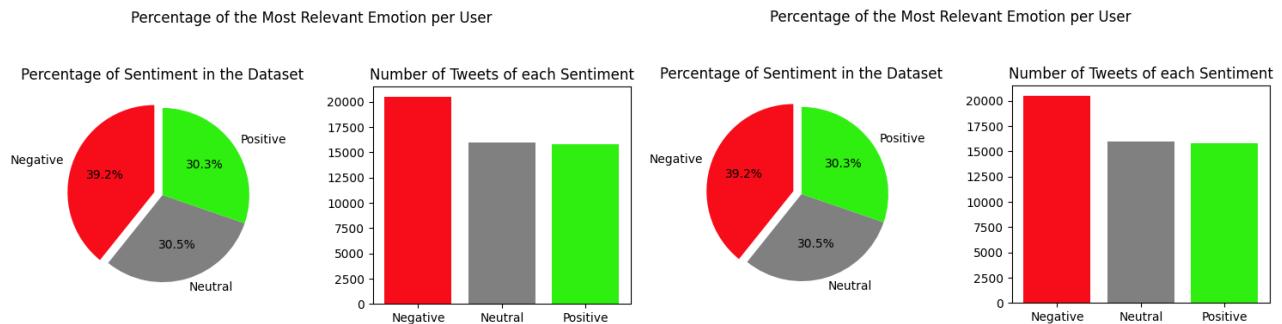
Unfortunately on the subset of the dataset we decided to work on didn't return any kind of meaningful data about the movement, meaning that we didn't collect the correct data or nobody discussed about it before.

On the other hand the data of the period after the felony managed to generate meaningful information:

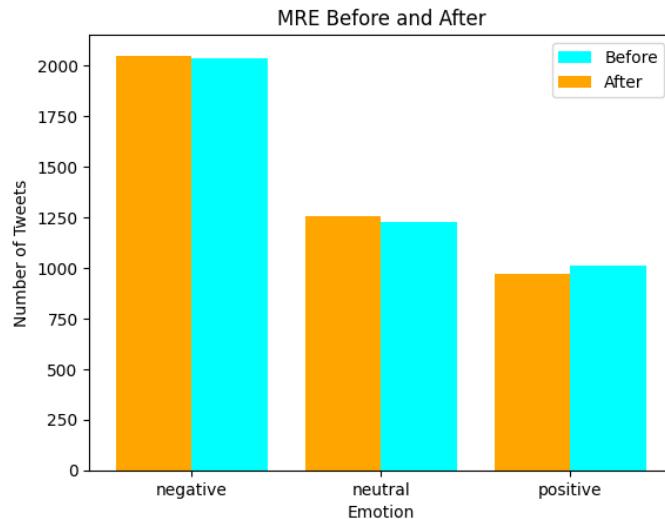


An observable difference is the percentage of the emotions towards the topic; during the analysis of the overall dataset we determined that the overall sentiment was negative while the users who specifically mentioned the account of the movement are mostly positive, this could be caused by the evaluation and collection of unnecessary information.

By analysing the most relevant emotion of users who tweeted both before and after we managed to generate the following bar chart:



And if we compare the two different periods we can notice that the most common emotion before and after is negative:



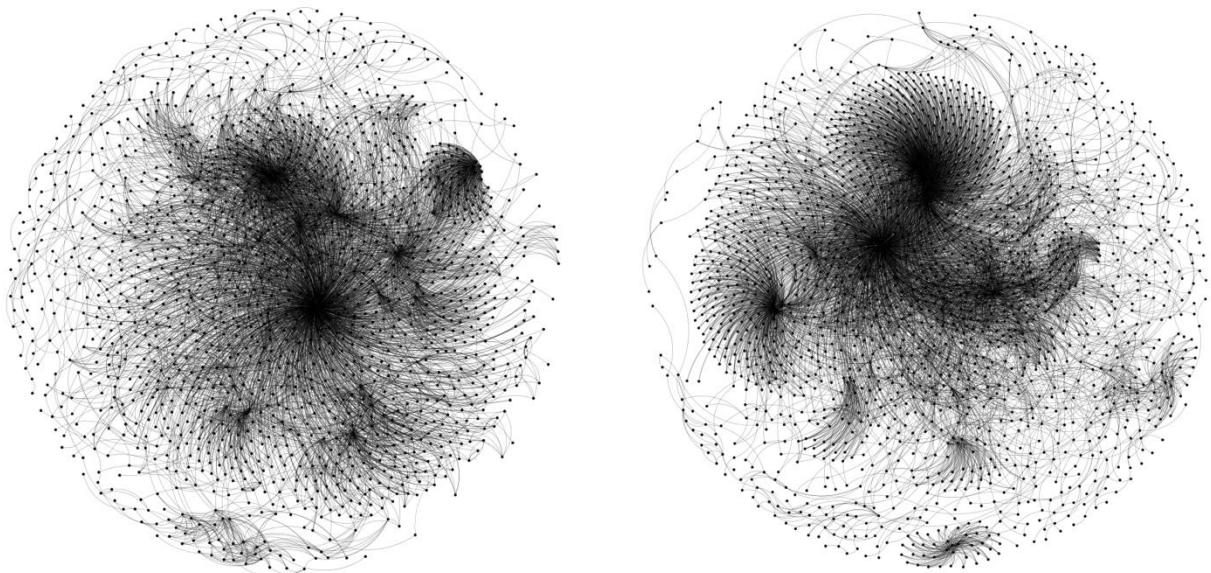
Now if we analyse and compare the dataframes we can determine that:

- 70.3% of the users changed opinion
- 29.7% remained the same

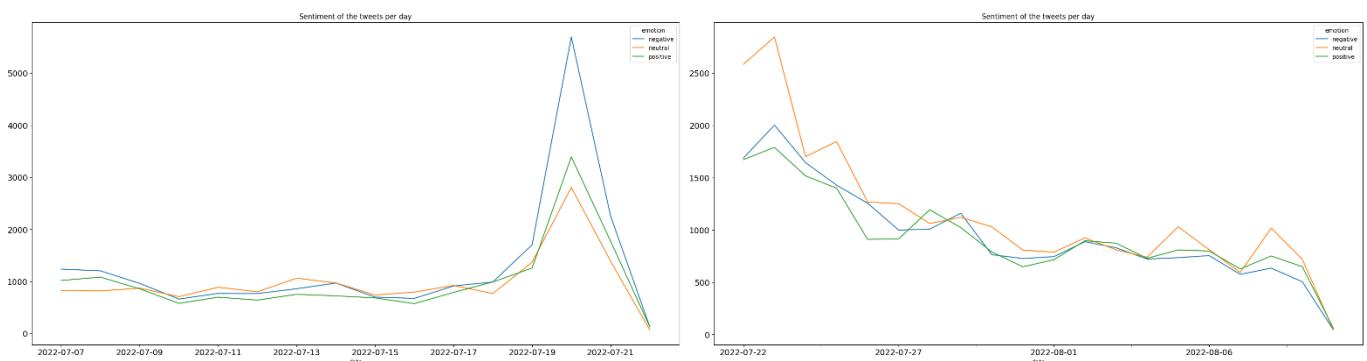
The emotion that was most switched to and also switched from is negative.

4.5.4 Uffizi Gallery, Florence

In midsummer 2022 italian environmental activists from the environmental activist group “Ultima Generazione” glued their hands to the glass protecting Sandro Botticelli’s piece of work “Primavera”. Fortunately the painting wasn’t damaged at all and the italian police officers said two young women and a man bought entrance tickets and staged the protest in the Uffizi’s room dedicated to the painter. The three were later taken to a police station in Florence. Italian media said the activists were issued official orders to stay out of the tourist-popular city for three years, using a strategy in Italy similar to that often applied to violent football fans.



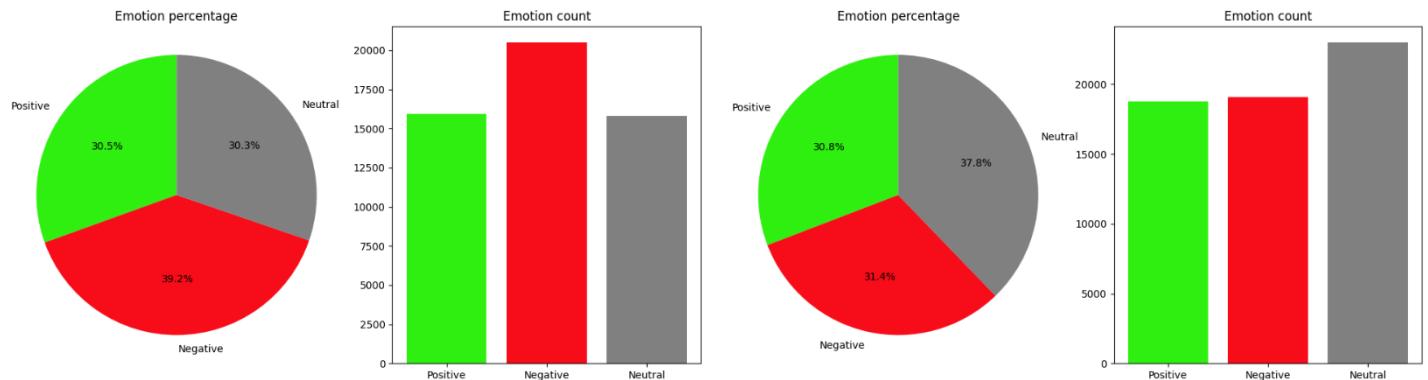
The networks created with Gephi from the csv files show that there are no noticeable clusters and there isn't a huge difference between them.



As we can notice the same trend appears in every multi-line chart about the number of tweets of each emotion.

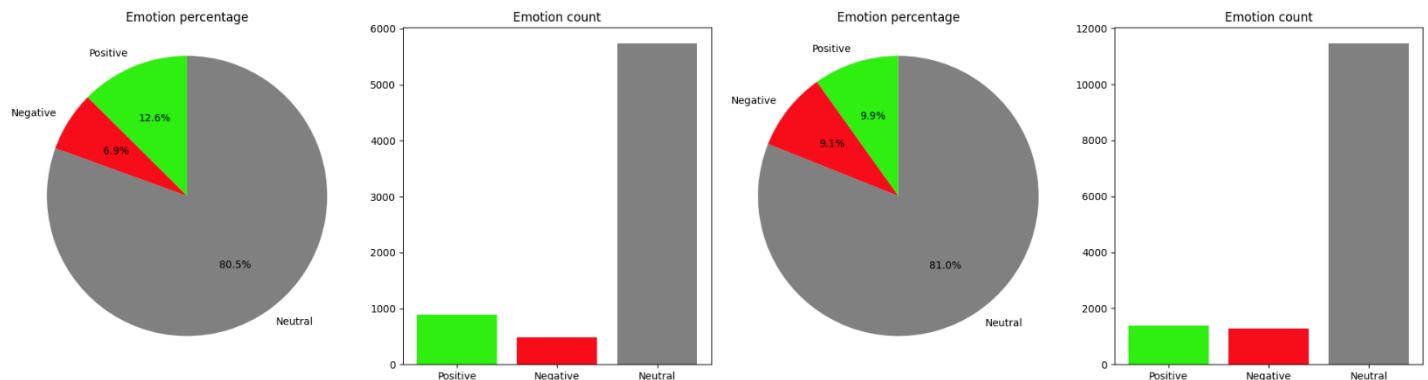
From these chart we can determine that the negative emotions were more relevant before the event, while after it seems like the neutral emotion prevailed.

We can confirm this affirmation by analysing the dataset:



By comparing the two time periods there seems to be a change in the most common emotion inside the whole dataset.

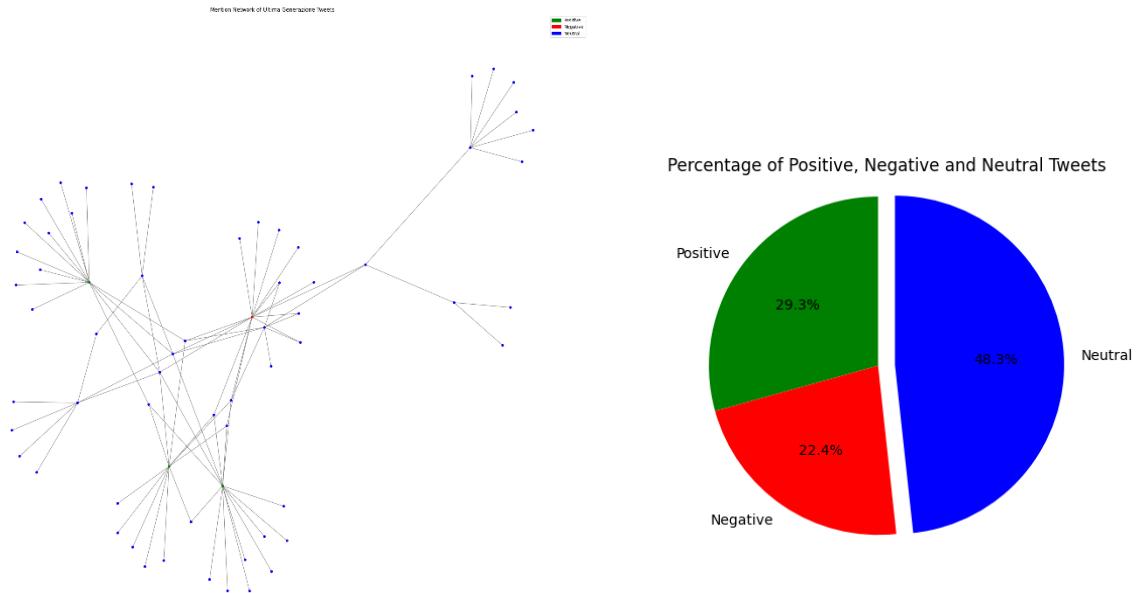
But if we were to narrow down the number of users to only the tweets labeled as Italian we'll find ourselves with a very different outcome:



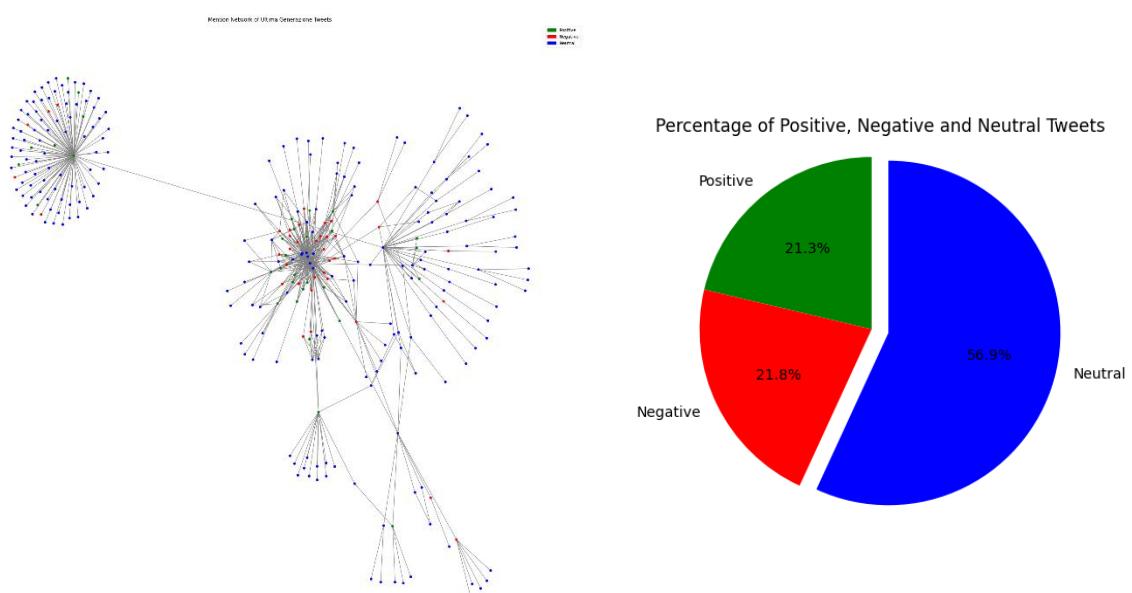
The most shared emotion between the locals is mostly neutral which isn't the same as the previous charts, meaning that there might be a presence of cultural bias that affected the judgement of the italian users who had objective observations towards the topic of the climate crisis.

The activists who glued themselves on the painting were part of the italian environmental movement “Ultima Generazione”, therefore we will also analyse the mention network towards this subject in order to determine the impact they had on the users of the social platform.

Before

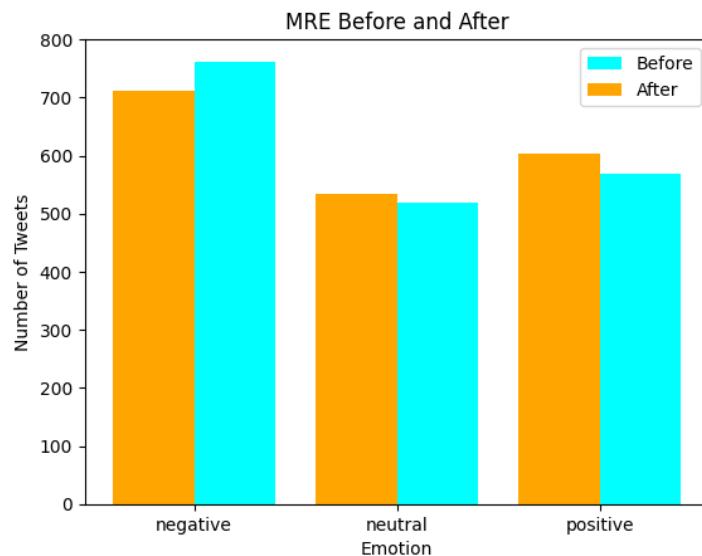


After



The only remarkable differences between the two analysis is the size increase of the mention network and the increment of the neutral emotion.

In order to determine the percentage of users who changed their opinion we will perform the MRE analysis on both of the dataset and compare them:



By narrowing down the dataframe to people who tweeted both before and after we can see that the most common emotion is negative, but it doesn't necessarily mean that no one changed opinion, in fact:

- 52.8% of users had a different opinion afterwards
- 47.2% remained the same

And it seems like most people changed their emotion from and also to neutral.

5. Conclusions

The data we worked regarding the Louvre and Uffizi's Gallery events showed most people who had the opportunity to express their opinions about it left neither positive nor negative feedback; which was surprising, given that we are working with data obtained from the Twitter platform. This means that most users have decided to be more objective towards activists, setting aside their emotions.

However, this phenomenon could be caused by the fact that the works were not really damaged, being protected by glass, and even if they were, they could be easily restored due to the slight damage received.

But as shown before the events regarding the Padro's Museum and the National Gallery of Art events had an overall negative feedback, which might be caused by various biases we didn't consider, causing the data to be faulty.

Another justification for the amount of neutral emotions could be the importance of the topic conveyed through the messages that activists tried to spread, namely the climate crisis and the possible consequences it could bring. The climate change is a topic of great importance and recognized as one of the biggest challenges that current society must face. Its importance is confirmed by the vast scientific community that has produced unequivocal evidence of its impact on the planet's ecosystem and the impact it could have on human life. Climate change is caused by human activities such as the use of fossil fuels, agriculture, and industry, which release large amounts of greenhouse gases into the atmosphere, causing an increase in global temperature. Such an increase is causing climate and environmental changes, such as rising sea levels, reducing water resources, destroying natural ecosystems, and reducing biodiversity. For this reason, climate change represents a threat to food security, public health, and social equity and has become a priority for governments worldwide. Many countries have adopted policies and programs to reduce greenhouse gas emissions and promote renewable energy sources, but much more needs to be done to address this global challenge. In summary, climate change was already considered a very important matter by most people and any acts of vandalism involving the damage of artworks will not change people's views on it or it might even return undesired feedback from the public.

In response to the continuous attacks on art pieces some museums are debating how to adapt to climate activism in their halls, which is really hard to prevent since museums are open space for people to discover and admire the history and culture of different countries.

The only way to prevent these attacks is to increase the security levels and implement a more thorough inspection of people who might be suspicious, in fact some guards in different museums were already able to stop some attackers from entering the museum.

In conclusion, through momentary acts that only cause temporary reactions, we will never achieve a substantial change to prevent the climate crisis. There are many possible solutions, and damaging works, blocking traffic, vandalizing buildings with paint, are not among them. To achieve this goal, we must raise awareness among governments and companies about their effects, leading to the implementation of climate policies and regulations, promoting the use of renewable energies and investment in sustainable technologies.