

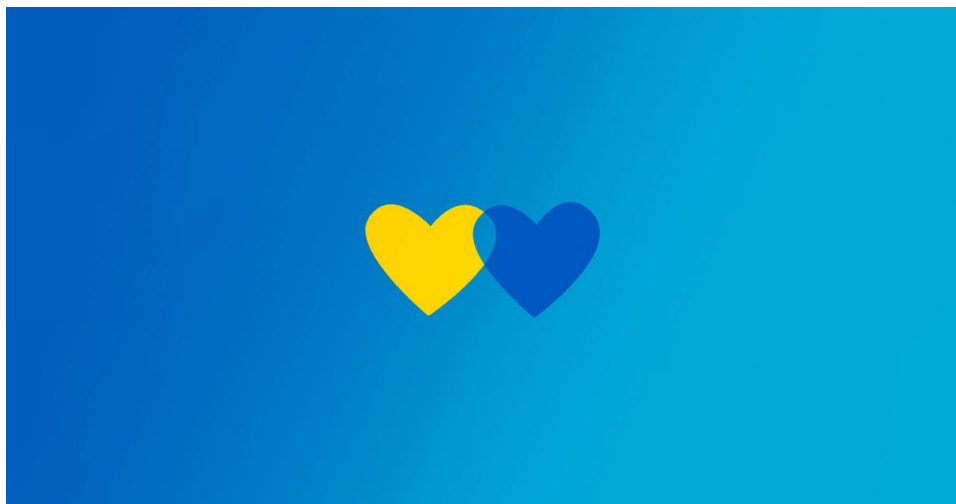
**MIE 1624 Introduction to Data Science and Analytics – Fall 2022**

## **Sentiment Analysis Course Project**

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## Executive Summary

As the ongoing Russo-Ukrainian war started by Russia continues, we must understand the socio-political developments of the public during these times of political instability. We applied a sentiment analysis, specifically Natural Language Processing on tweets to categorize them as either a negative or positive sentiment. Our team looks to analyze social media tweets to gauge the public's view on Ukraine and answer the underlining question "What can public opinion tell us about Russia's war against Ukraine in 2022?" We look to provide insights on key factors, reasons, and topics that drive public's sentiment and campaigning strategies to politicians, media, and other organizations to improve Ukraine's public image.

We approached the case study by developing a text classification sentiment analysis model. This model was used to divide social media datasets into negative and positive tweets, from Dataset 1 (retweets from Elon Musk) we found the distribution to be mostly negative posts. Using the negative and positive tweets, we located keywords individually in the positive and negative sentiment classes. Although we found many words appearing in both the positive and negative word clouds, we selected 10 words that have the potential to provide insights into the sentiment. Those words were "Crimea, Donbas, referendum, independence, money, border, Starlink, peace, Putin, and Elon". To help categorized each word we computed the ratio percentage for each word in either the positive or negative class. "Independence, Starlink, and peace" showed the highest ratio for positive tweets, while independence and peace were expected as they are positive words, Starlink was an interesting word that stood out.

Through further analysis, we located two words that we believed could be utilized through campaigning strategies to help improve Ukraine's public image. These were StarLink and Crimea. StarLink is a network of more than 2,000 satellites operated by SpaceX that provides satellite internet access cover to over 40 countries. Starlink has been quite useful for Ukrainian citizens, with internet access Ukrainian citizens have access to communicate with one another and share the terrible reality of the Russo-Ukrainian war. But with Elon Musk, the CEO of SpaceX, no longer providing StarLink to Ukraine at no charge, we believe it would be in Ukraine's best interest to find a way to pay for these services. We believe that the ability of Ukraine to communicate with the public could play a large factor in the socio-political development of the Russo-Ukrainian war.

Another topic was Crimea, the geographical location of Crimea is important to Russia since Crimea's Black Sea ports offer rapid access to the Eastern Mediterranean, the Balkans, and the Middle East. From our analysis, we saw a large negative sentiment when mentioning Crimea or the referendum. We suggest, if possible, considering the US proposition where the referendum would be performed under a trusted entity. Although you may be losing Crimea it far outweighs the war that is currently affecting Ukraine. In addition, with such a high importance on Crimea, a potential solution would be to try and gain support from other countries to help regain Crimea. Whether this is from neighboring countries or an organization like NATO, taking away a key location from Russia would have an impact on Russia's resources to continue the war.

## Introduction

On February 24th, 2022, Russia invaded Ukraine. This global event is still ongoing, and many people are discussing it on Twitter. We performed a sentiment analysis on a dataset that contains tweets related to the war. The analysis provides a comprehensive picture of public perception. Using our results, we identified factors/reasons/topics that drive either a positive or negative sentiment. We also provided suggestions on how Ukraine and the war are viewed internationally and suggest actions that could improve its image.

As mentioned, the primary analysis method of this project is Sentiment Analysis. We will use this machine learning method to analyze current events and make suggestions. Sentiment analysis is an application of the language processing (NLP) method, which analyzes, processes, summarizes, and predicts subjective text with a specific sentiment and uses some emotional indicators to quantify target data (IBM Cloud Education, 2021). [1] In our analysis, we classified tweets as either positive or negative. After classifying the tweets appropriately, we extracted keywords from each tweet. We used those keywords to provide suggestions on how Ukraine can improve its image. For analyzing public opinion orientation, governments can understand people's emotional tendencies toward events to conduct public opinion timelier and effectively create policy support.

## Background

The Russo-Ukrainian War has been ongoing since February 2014, along with Russian separatists in Ukraine. The conflict escalated significantly when Russia launched a full-scale invasion of Ukraine in February 2022. The war that Russia has unleashed on Ukraine has a global impact beyond the death toll and human tragedy in Ukraine itself and the resulting refugee flows and broader destabilizing effects on Eastern Europe. It has a ripple effect. This infographic shows some of the economic effects of war on Europe and the rest of the world. EU Member States are closely coordinating actions to address rising prices and supply shortages. Energy prices have risen sharply in the EU and globally since late 2021. Fuel prices continue to rise due to Russia's provocative and unjustified attacks on Ukraine, raising concerns about the EU's energy security. The situation was further affected by Russia's decision to suspend gas supplies to several EU member states. A Russian military attack on Ukraine will directly impact global food security and affordability. The Ukraine invasion also has significantly impacted the movement of people and goods within the EU of transport. (*EU response to Russia's invasion of Ukraine - consilium - europa* 2022). [2]

In the war between Russia and Ukraine, there were physical conflicts, information warfare, and public opinion conflicts on the Internet, which became essential in the early stage and throughout contemporary wars. This also means that real-time monitoring and analysis of public opinion on the Internet is necessary for both sides of the war. Sentiment analysis was heavily used in this war to predict the direction of public opinion and support Ukraine's international influence (*Russia's war on Ukraine: Background - European Parliament* 2022). [3]

## Client Profile

The main clients of the project are the Ukrainian government, Ukrainian supporters, and all stakeholders who have business relations with Ukraine. Through the analysis of replies on Twitter, these clients can understand the current bias of Twitter users around the world towards the war between Russia and Ukraine. After analyzing specific phrases, related business or political strategies can be formulated. Raise global awareness of the Russia-Ukraine war and help Ukraine gain higher support for the war.

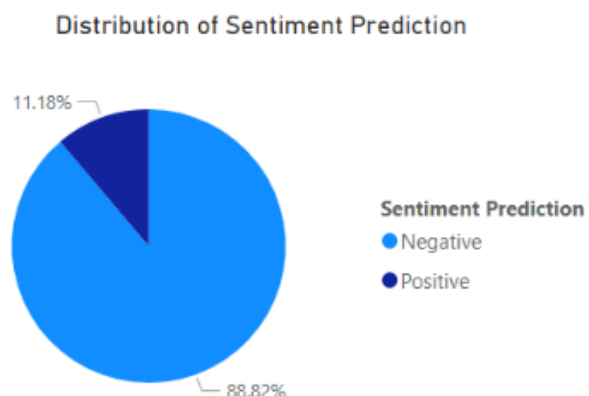
## Objectives

Socio-political development addresses questions about nationality, citizenship, identities, trust, and values. As the ongoing war started by Russia continues, we must understand the socio-political development of the public on Russia's war against Ukraine. By understanding the international public scene, parties such as government agencies or news outlets can view the public sentiment and potentially use this information to help influence the image of various parties.

Through sentiment analysis of social media posts and tweets through popular social media platforms, we will answer the question, "What can public opinion tell us about Russia's war against Ukraine in 2022?" Our objective is to understand the current trends and insights into the war between Ukraine against Russia. We will develop and use existing NLP sentiment models to classify positive and negative social media posts. With these classes of positive and negative social media posts, we will analyze deeply to identify factors, reasons, and topics that drive sentiment. Presenting findings to suggest changes in the Ukrainian government and international NGOs' current portfolio strategy that will help influence and create a favorable international presence for Ukraine.

## Observations (Analysis)

In our analysis, we trained a model to predict whether a text can be classified as a positive or negative sentiment. After training the model, we looked at two datasets that contain tweets to classify them. The first dataset, which we'll name (dataset 1) in the rest of this report, consists of retweets from 16 tweets Elon Musk made regarding the war. The second dataset (dataset 2) we used was a dataset of tweets that contained the hashtag `russsiaukrainewar`. It is noted that most of the insightful results we found were from the first dataset, and we will not



*Figure 1 Distribution of Sentiment Prediction*

mention the second dataset too much. Some results obtained are going to be available in the Appendix.

Using our model, we predicted each tweet to see whether it was positive or negative. The result was that a vast majority of tweets had a negative sentiment. This is expected as the tweets are related to war. **Error! Reference source not found.** illustrates the distribution between the positive and negative predictions.



Figure 2 Positive Word Cloud for Dataset 1 using keyword

From the word cloud, we can see multiple interesting words. We observe that some words appear in both the positive and negative word clouds. We decided to analyze further in detail the following ten words: Crimea, Donbas, referendum, independence, money, border, StarLink, peace, Putin, and Elon.

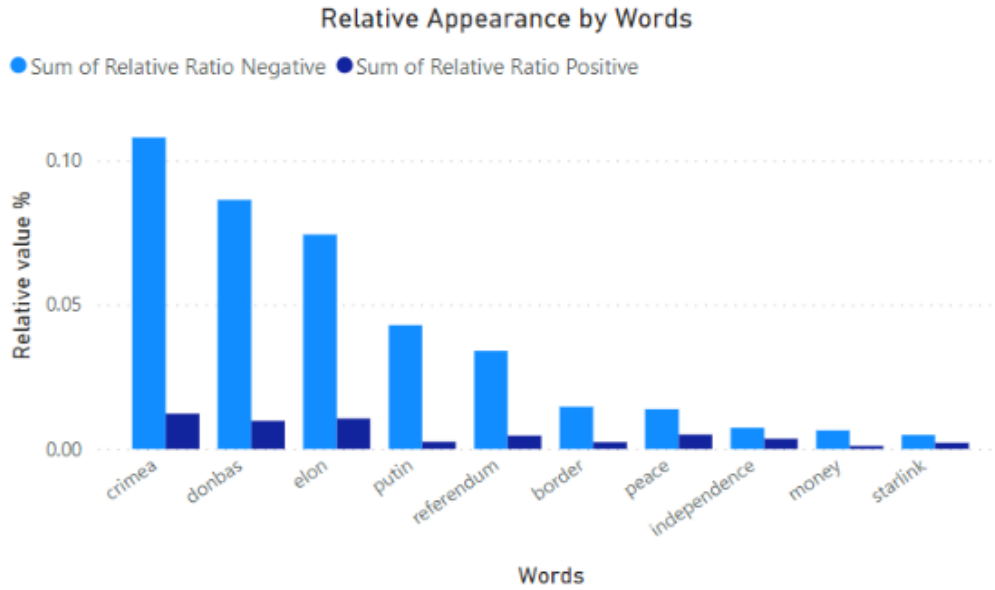


Figure 4 Relative Appearance by Words

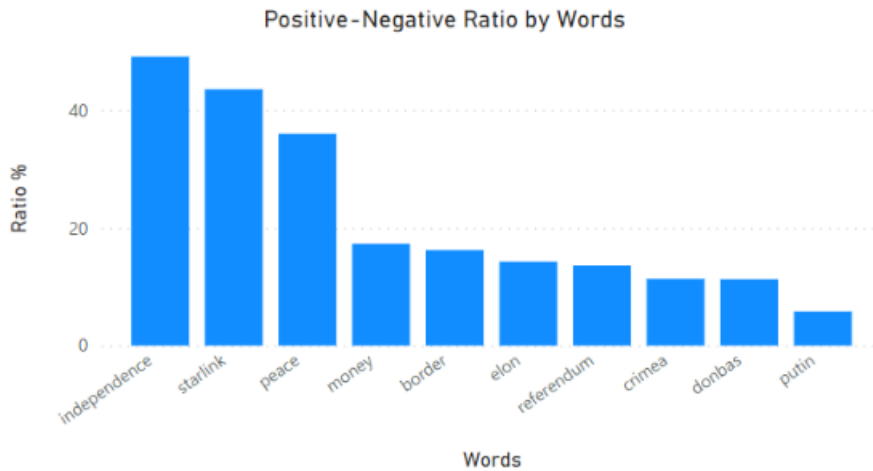


Figure 5 Positive-Negative Ratio by Words

Looking at Figure 5, we can see from highest to lowest which words are more related to positive sentiment. Some results are expected, for example, peace having a strong positive relationship and Putin having a low positive one. We decided on two groups, leading to our suggestions in the following section. We analyzed why StarLink might have such a high positive ratio, and we analyzed Crimea, the referendum, and independence together as they are closely related.

Among the words, Starlink has the best positive ratio. This is mainly because it provides wifi for people in Ukrainian. However, its score is still relatively low. We explored some of the recurring



themes in the negative sentiment for StarLink. We saw that some people expressed positive sentiments towards Starlink, such as the following tweet:

- *@elonmusk, I'm from Ukraine. I want to say thank you for Starlink in my army. This is so much help!!! Thank you*

However, on October 24<sup>h</sup>, Elon Musk shut down 1300 SpaceX satellite units over some funding issues. [<https://www.cnn.com/2022/11/04/politics/spacex-ukraine-elon-musk-starlink-internet-outage/index.html>]. This was after initially providing StarLink to Ukraine for free. Many people had negative feelings toward what he did. The following is an example of someone expressing a negative sentiment toward StarLink.

- *@elonmusk Elon didnt 'give' Ukraine Starlink, he wants a quick return on the 'investment'.*

Hence, this explains why its positive score is low despite giving access to the Internet. We then analyzed why the referendum and Crimea sentiments were among the lowest. Most tweets related to Russia's annexation of Crimea and the referendum. Some expressed that the referendum would not make sense as either it would be rigged/forced to vote for someone, as the following tweet suggests:

- *@elonmusk Dear businessman, there is no point in asking this question because this referendum was already held in Ukraine in 1991. There is no point in having a referendum again at gunpoint...*

## Suggestions

### StarLink

One keyword, 'StarLink,' stood out among the phrases with positive sentiment. Founded by Elon Musk, StarLink is a network of more than 2,000 satellites orbiting the earth, which can communicate with terminals on the ground. After Russia invaded Ukraine in February, Ukraine experienced a massive internet outage. The existence of StarLink becomes meaningful, not only providing network support for the people of Ukraine but also providing communication support for the Ukrainian army on the front line of the battle (Vinion, 2022). [4]

The importance of StarLink for Ukraine is quite essential for its citizen, but also for Ukraine's image. Providing Ukrainian access to the Internet could increase the exposure to Russia's invasion of Ukraine. Giving Ukrainian access to the Internet might lead them to record the cruelty of war and share it with the world, such as urban ruins and injured residents. This could showcase what is happening in Ukraine to some people unaware of the situation.

Elon Musk started by providing StarLink to Ukraine without charging them. However, in October of 2022, he started charging Ukraine for StarLink. On top of that, the price is set to increase by in December 2022 by 25 % for Ukrainian (Kay, 2022). [5] The prices may continue to go up as Elon

realizes that the war is affecting Ukraine's mobile phone networks (Stepanenko & Keaten, 2022) [6]. We propose the following 2 suggestions to the Ukrainian government.

Given the importance of StarLink, we suggest Ukraine to borrow money from countries if they need it too. Several media reports said the U.S. military and the European Union were considering paying for StarLink to help support war-torn Ukraine (Hunder & Balmforth, 2022) [7]. We also highly recommend that Ukraine's government negotiate with Elon Musk on either lowering the fees or agreeing on keeping the rate fixed for a certain period.

## Crimea

The geographical location of Crimea is important to Russia since Crimea's Black Sea ports offer rapid access to the Eastern Mediterranean, the Balkans, and the Middle East. Historically, possession of the south coast of Crimea has been sought by most empires since ancient times (Roman, Byzantine, Ottoman, Russian, British, French, Nazi, German, and Soviet) (Wikimedia Foundation, 2022) [8].

In 2014, Crimea was illegally seized and annexed by Moscow. Russia launched a full-scale invasion of Ukraine on February 24, 2014. The United States has proposed to the Kremlin a peace deal that would see Russia withdraw from all Ukrainian territories except Crimea. After seven years, it will hold a referendum on its future (MacKinnon, 2022) [9]. From our analysis, we saw that people had negative sentiments when mentioning Crimea or the referendum. We suggest Ukraine two options.

The first one is to consider the US proposition under the following conditions. The referendum would be performed under a trusted entity. There are better situations than this. However, we believe that stopping the war outweighs the negative of losing Crimea for a few years. Also, the negative sentiment towards a false referendum will be gone.

The second proposition is to try to get more support from other countries to regain Crimea. This proposition is riskier and would require the collaboration of multiple countries. Another suggestion that we have is to get support from more countries. The Ukrainian government could ask Nato to get further assistance in weapon funding and try to regain Crimea.

We may prompt the history behind the annexation of Crimea to the public to enhance awareness of this illegal invasion of the world. Germany's reaction to the 2014 annexation of Crimea could have been stronger, according to the chairman of the Munich Security Council (Euromaidanpress, 2022) [10].

## Conclusion

In conclusion, we analyzed tweets about Ukraine and Russia's current war situation. From our analysis, we showcased that most of the tweets show negative sentiments regarding the war. After extracting words from the tweet, we analyze them in detail with the ten keywords: Crimea, Donbas, referendum, independence, money, border, StarLink, peace, Putin, and Elon. By plotting the relative appearance and Positive-Negative Ratio by words, we found that 'Independence,' 'StarLink,' and 'peace' have a powerfully positive relationship. In contrast, 'Crimea' and 'referendum' have a low positive relationship. Starlink stood out in the positive sentiments as it is an important topic to Ukraine.

Starlink was provided by Elon Musk to Ukraine without charging them. It provides network support to the Ukrainian people and communications support to the Ukrainian military on the front lines of the battle. Starlink was also associated with negative sentiment as people had negative feelings about Elon Musk shutting down 1300 SpaceX satellite units and starting charging Ukraine for Starlink.

Furthermore, we pointed out the reason that led referendum and Crimea to a low score of a positive relation. By observation, we notice that most tweets are associated with Russia's illegal invasion of Crimea and the referendum. Some tweets expressed that the referendum is not reliable and is rigged to vote for someone. We may suggest Ukraine to borrow money from other countries for supporting the network. What's more, we may suggest the Ukraine government to negotiate with Elon Musk to lower the price of Starlink or keep the price in an affordable range. Talking about the importance of Crimea, we may suggest considering the State's proposition, performing the referendum under a trusted entity, or trying to get more help from other countries to return Crimea.

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## Appendix

*Table 1 Top three most liked tweets*

<b>Tweet</b>	<b>text</b>	<b>Sum of like_count</b>	<b>Sum of reply_count</b>	<b>Sum of retweet_count</b>
1	<p>Ukraine-Russia Peace:</p> <ul style="list-style-type: none"> <li>- Redo elections of annexed regions under UN supervision. Russia leaves if that is will of the people.</li> <li>- Crimea formally part of Russia, as it has been since 1783 (until Khrushchev's mistake).</li> <li>- Water supply to Crimea assured.</li> <li>- Ukraine remains neutral.</li> </ul>	1851997	47614	92642
2	<p>Let's try this then: the will of the people who live in the Donbas &amp; Crimea should decide whether they're part of Russia or Ukraine</p>	842719	25808	41974
3	<p>'@RenataKonkoly Russia is doing partial mobilization. They go to full war mobilization if Crimea is at risk. Death on both sides will be devastating.</p> <p>Russia has &gt;3 times population of Ukraine, so victory for Ukraine is unlikely in total war. If you care about the people of Ukraine, seek peace.</p>	470054	13448	14279



Figure 6 Positive Word Cloud Dataset 1 (Word Frequency)



Figure 7 Negative Word Cloud Dataset 1 (Word Frequency)



Figure 8 Negative Word Cloud Dataset 2 (Word Frequency)



Figure 9 Positive Word Cloud Dataset 2 (Word Frequency)

*Table 2 Word Summary*

Words	Sum of Word Count Positive	Sum of Relative Ratio Positive	Sum of Word Count Negative	Sum of Relative Ratio Negative	Sum of Positive- Negative-Ratio
border	19	0.0024	117	0.0146	16.24
crimea	98	0.0122	864	0.1078	11.34
donbas	78	0.0097	691	0.0862	11.29
elon	85	0.0106	595	0.0742	14.29
independence	29	0.0036	59	0.0074	49.15
money	9	0.0011	52	0.0065	17.31
peace	40	0.005	111	0.0139	36.04
putin	20	0.0025	344	0.0429	5.81
referendum	37	0.0046	272	0.0339	13.6
starlink	17	0.0021	39	0.0049	43.59