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Sentiment Analysis of Swedish and Finnish Twitter Users' Views Toward NATO Pre- And Post- 2022 2nd Russian Invasion of Ukraine

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SENTIMENT ANALYSIS OF SWEDISH AND FINNISH TWITTER USERS' VIEWS TOWARD NATO PRE- AND POST- 2022 2ND RUSSIAN INVASION OF UKRAINE

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Dedication

I dedicate this thesis to the exceptional individuals who have been instrumental in shaping my academic journey and making this research possible. First and foremost, my sincere gratitude goes to my esteemed advisor, Dr. Zhenlong Li. His unwavering support, insightful guidance, and boundless patience have been the driving force behind my progress. His expertise and mentorship have enriched my understanding of the subject, and I am immensely grateful for the countless hours he dedicated to nurturing my growth as a researcher. I would also like to express my heartfelt appreciation to my committee members, Dr. Carl Dahlman and Dr. Robert Kopack. Their valuable feedback, constructive criticism, and valuable insights have been pivotal in refining my work and enhancing the quality of this thesis. Their encouragement and scholarly wisdom have inspired me to push the boundaries of my academic pursuits. Special thanks to Huan Ning, a dedicated member of the GiBD Lab, for his diligent efforts in data collection and processing. His assistance and technical expertise significantly contributed to the success of this research. To each of you, I extend my deepest thanks for believing in my potential, challenging me to reach new heights, and instilling in me the confidence to overcome any obstacles along this journey. Your collective impact on my academic and personal growth has been immeasurable, and I am privileged to have had you as my mentors and collaborators.

Abstract

This study seeks to analyze the changes in Swedes' and Finns' opinions toward the North Atlantic Treaty Organization (NATO) in light of the 2022 2nd Russian Invasion of Ukraine. To do so, a large dataset of geotagged tweets containing keywords related to NATO is analyzed using lexicon-based sentiment analysis to study spatiotemporal trends. The study shows that overall discussion remains very neutral, with less than a quarter of all tweets having a non-zero sentiment score, and differs markedly from public opinion polling in both countries while spatiotemporally, the discussions is concentrated in the major population centers and exhibits little month over month variation after the commencement of hostilities.

Table of Contents

List of Figures

List of Tables

Chapter 1: Introduction and Project Description

Security policy in northern Europe has, for the past 100 years, been marked by the neutrality of its two greatest powers, Sweden and Finland. In Sweden's case, this neutrality policy was part of a longstanding tradition, going back to the Napoleonic Wars, of avoiding conflicts on the continent (Dalsjö, 2017). In Finland's case, neutrality was imposed by the Soviets as a condition for peace at the end of the Second World War (Dalsjö, 2017; Wieslander, 2019; Zimmermanová et all, 2020). Both countries' governments had cause to reevaluate their policies in the wake of Russia's 2022 and subsequently 2nd Invasion of Ukraine, an event which led to them requesting to join the North Atlantic Treaty Organization (NATO). As the invasion raged, with footage of fierce combat being uploaded to the internet and shown on every major news network, the Swedish and Finnish governments rethought their views of NATO and whether joining the alliance was sensible from a geopolitical standpoint. Stunned by the scale of the conflict so close to home, their populations also began to rethink their longstanding views of the alliance. This reevaluation saw views of NATO go from neutral to overwhelmingly positive (Novus, 2022; Yle News, 2022). Amidst the countries' reassessment of their longstanding policies and the ongoing heated debates in the public sphere, a smaller yet significant microcosm of these discussions unfolded on Twitter.

Sweden and Finland joining NATO represents a major geopolitical shift in Northern European politics. To go from loose associates to NATO candidates, a process which can take years under normal circumstances, in only four months is unprecedented. This study measured the change in sentiment in discourse surrounding NATO amongst Swedish and Finnish Twitter users. It also measured how the alliance was viewed in the two countries pre- and post-invasion and examined spatial aspects of users tweeting about NATO.

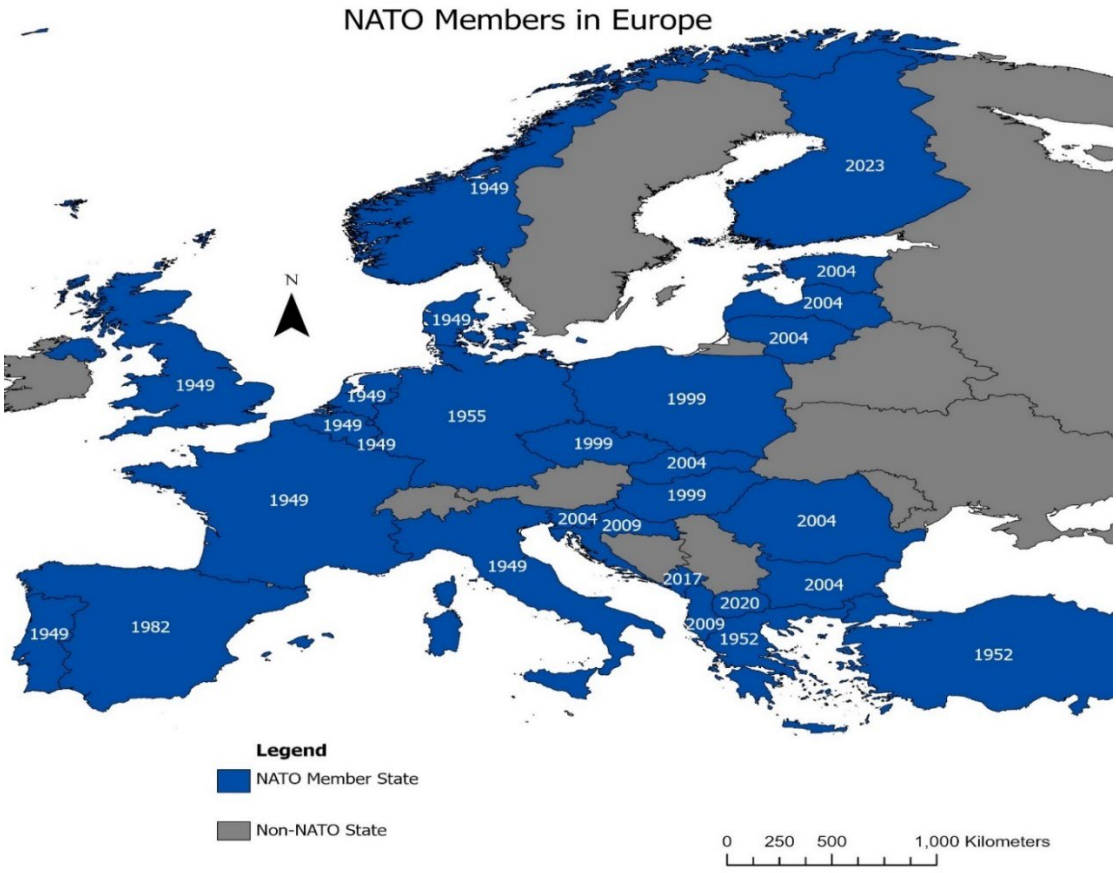

Figure 1.1. A map of Europe showing all current NATO members in blue

Twitter is a popular microblogging website with about 313 million users globally as of 2019 (Malik et. all). Twitter allows users to communicate using messages of up to

280 characters known as tweets (Guha and Pande, 2021). These tweets can contain user included hashtags, which are key words or phrases denoted by the # symbol. Hashtags serve to index the tweet as relating to a particular topic (Greenhalgh et al., 2021).

Discussions of NATO on Twitter by users in in Sweden and Finland created data that could be studied in numerous ways. Sentiment analysis, one such way, is a process by which tweets are analyzed for desired content and given a numerical score that allows them to then be categorized as negative/neutral/positive (Dahal et. al, 2019). Performing sentiment analysis on a sample of tweets allowed the author to track whether or not there was wider change in public sentiment towards NATO in the two countries.

This study analyzed geotagged Twitter data acquired using Twitter's Academic Application Programming Interface (API). The API allows the content of tweets, in addition to detailed metadata on the tweets and the users who posted them, such as post location and the user's join date, to be extracted and collated for study.

Chapter 2: Research Questions

This thesis primarily contributes to literature on sentiment analysis, with additional minor contributions relating to the political geography of Northern Europe. It will do that by conducting sentiment analysis on tweets that were originally written in other languages to explore views of the rapid shift in defense policy by the governments of Sweden and Finland. Sweden and Finland were chosen for this study because they were the only two countries in Europe with significant military capabilities that were both non-members of NATO and not directly hostile to the alliance. The time period of June 2021 to June 2022 to was chosen as it allows for study of sentiment from a pre-war "baseline" through to after the NATO accession process had begun. This study will focus on answering the following research questions and subquestions:

1. How did views, defined here as sentiment scores of tweets, of NATO change amongst Swedish and Finnish Twitter users over the period June 2021 to June 2022?
    a. Specifically, how was NATO viewed when the threat of war was remote?
2. How are the tweets distributed spatially? i.e. are they from people close to where Russia could easily attack, such as the border or coast?
    a. Did this spatial distribution have any effect on sentiment? I.e. were tweets from users closer to Russia more likely to be pro NATO

3. How did sentiment vary by language?
    a. Specifically, did tweets not in Swedish or Finnish vary from those in them?

Chapter 3: Popular Geopolitics of NATO Membership

Evolution of Nordic Security Policy

Sweden's governments have maintained a policy of neutrality for almost 200 years. This policy was formed in the wake of the loss of the Swedish Empire as a way to avoid being drawn into conflicts with superior foes on the continent (Dalsjö, 2017). In the wake of the Second World War, this policy gradually began to shift in response to the threat posed by the Soviet Union. Initially there were calls for a neutral military alliance made up of Sweden, Finland, Norway, and Denmark as a way to balance the United States' and Soviets' influence in Northern Europe (Petersson, 2012; Dalsjö, 2017). When this proved unacceptable to the United States government, a compromise was reached where Denmark and Norway would join NATO while Sweden and Finland would remain neutral (Wieslander, 2019). This neutrality didn't stop successive Swedish governments from collaborating with NATO however, with intelligence sharing and joint war planning being common practice throughout the Cold War (Dalsjö, 2017; Wieslander, 2019; Zimmermanová et all, 2020).

The security policy of Finnish governments dating back to independence in 1917 has always been influenced by Russia. It gained independence from the Russian Empire as it collapsed during the Russian Civil War and has been attentive to some form of Russian aggression and territorial ambitions ever since. Finland's governments did attempt to

form alliances with other nations during the interwar years, but eventually chose to adopt the neutrality policy of its closest diplomatic partner, Sweden, when potential allies proved to be less than forthcoming. Neutrality did not protect Finland, as the Soviet Union invaded shortly before the start of World War Two in a series of wars knowns as the Winter War and Continuation War. After the wars' conclusion with the Allied victory in World War Two and the attempt at a neutral Scandinavia (Wieslander, 2019), the governments of Finland and the USSR signed a treaty of mutual friendship that essentially guaranteed Finnish neutrality during the ensuing Cold War (Zimmermanová et all, 2020).

After the Cold War's conclusion in 1991, the Finnish and Swedish governments resumed their previously close defense cooperation. Amid the rapidly changing security situation in Europe marked by the collapse of the USSR and Warsaw Pact and the realization that neutrality may not be the shield it once was, the two countries' goverments jointly decided to openly engage with NATO as part of the Partnership for Peace program begun in 1994 (Dalsjö, 2017; Wieslander, 2019; Zimmermanová et all, 2020). This engagement led to both countries deploying military forces as part of the NATO-led peacekeeping mission in Yugoslavia, a move which Sweden's government at the time used to demonstrate its willingness to share the security burden of post-Cold War Europe (Henricsson, 2013). Both countries also contributed forces to the combat mission in Afghanistan (MÁRTON, 2013; Wieslander, 2019). In addition to cooperation with NATO, defense cooperation between both countries continued to deepen to include joint war planning (Wieslander, 2019; Lundqvist and Widén, 2016; Møller and

Petersson, 2019; Ydén et all, 2019). The two countries' entrance to the European Union also marked a shift in cooperation with NATO, as EU membership included defense obligation for its members, many of which were also NATO members (Dalsjö, 2017).

The 2008 Russian Invasion of Georgia marked a turning point in both countries' security stance, as they began to realize that Russia was capable of acting outside its borders and had designs on neighboring countries. This war, combined with the first Russian Invasion of Ukraine that led to the seizure of Crimea in 2014 and an overall increase in Russian belligerence, caused the governments of Sweden and Finland to reevaluate their then-current defense arrangements and decide to push for closer relations with NATO (Dalsjö, 2017; Wieslander, 2019; Zimmermanová et all, 2020). By 2018, Sweden was viewed by some experts as "Partner Number One" or even "The Allied Partner" (Petersson 2011, 2018; Wagnsson, 2011; Dahl 2012) and could be considered "more NATO than most NATO members" as its military was entirely equipped to NATO standards and in many cases more modern than NATO militaries (The Economist, 2007).

Public Opinion Regarding NATO in Sweden and Finland

In Sweden, public opinion on NATO has varied wildly in the time since the alliance was formed. During the Cold War Swedes viewed their neutrality though a lens of moral "goodness" (Dalsjö, 2017), while NATO was viewed more as a symbol of nuclear power, warmongering, and militarism by the superpowers (Cottey, 2013; Ydén et all, 2019). Despite the end of the Cold War and the increasingly open cooperation with NATO that followed, the Swedish population overwhelmingly opposed membership in the alliance

(Ydén et all, 2019). Over time, opposition changed and a slim majority of respondents to a public opinion survey answered in favor of NATO membership in 2015 (Ydén et all, 2019). Over the next several years, public opinion swayed back and forth, with neither side ever holding a large majority (Ydén et all, 2019). This situation remained until after the renewal of the war in Ukraine, with the Prime Minister at the time rejecting calls to join the alliance as late as March 8th (Reuters, 2022).

In Finland, neutrality has traditionally taken on a different tone, as it was enforced by the threat of Soviet invasion for much of the country's early existence. This has led to support for NATO membership varying from 16 to 34 percent, while opposition has historically remained as high as 58 to 79 per cent (Suomalaisten Mielipiteitd Ulko- Ja Turvattisuuspolitiikasta, Maanpuolustuksesta Ja Turvallisuudesta (Finns' Opinions of Foreign and Security Policy, Defence, and Security), 2006; Rahkonen, 2007). The variation in support is compounded by support for NATO membership among Finns being lower during major world crises, such as the war in Kosovo in 1999, in Afghanistan in 2001, and in Iraq in 2003 than in more peaceful times (Suomalaisten Mielipiteitd Ulko- Ja Turvattisuuspolitiikasta, Maanpuolustuksesta Ja Turvallisuudesta (Finns' Opinions of Foreign and Security Policy, Defence, and Security), 2006; Rahkonen, 2007). This change in support during times of crisis can be explained by a public opinion poll from 2004 suggesting that Finns did not want their country involved in remote crises (Rahkonen, 2007). Much like in neighboring Sweden, this situation persisted until the 2nd Russian Invasion of Ukraine in 2022, with the Prime Minister at the time stating that membership in the alliance was unlikely as late as January 2022 (Reuters, 2022a).

NATO

The North Atlantic Treaty Organization, also known by the acronyms NATO and OTAN, was founded in 1949 with the signing of the North Atlantic Treaty by representatives of the governments of the United States, United Kingdom, Iceland, Italy, Canada, France, Belgium, the Netherlands, Luxembourg, Denmark, Norway, and Portugal. The alliance's mission being "… to secure peace in Europe, to promote cooperation among its members and to guard their freedom – all of this in the context of countering the threat posed at the time by the Soviet Union." (Nato, 2022). At the time of its founding, approval for the alliance ranged from 76% amongst poll respondents in the US to 31% of respondents in (then neutral) Sweden (Gallup, 1972; Kostadinova, 2000). The alliance expanded slowly during the remainder of the Cold War, adding Greece and Turkey in 1952, West Germany in 1955, and Spain in 1982. In the post-Cold War era a belief began to prevail in Europe that the continent was at peace and no power threatened a major war. With Russia no longer being considered a threat along with NATO domination of military and security issues on the continent, and no other coalition of powers challenging its present stable security community (Rubinstein, 1997) questions arose regarding the necessity of NATO expansion (Kostadinova, 2000). The alliance did continue to expand during this time, with many states formerly occupied by the USSR (either as constituent republics or via the Warsaw Pact) and that emerged from the breakup of Yugoslavia joining over the next three decades, bringing its membership total to 30 in early 2022.

Since the end of the Cold War, NATO expansion has been closely linked to EU expansion, with most new EU members also being NATO members. Public opinion regarding NATO expansion, particularly in the countries formerly occupied by the Soviet Union either as constituent republics or as members of the Warsaw Treaty Organization (better known as the Warsaw Pact), varied greatly at the time of those countries' accession to the alliance. Opinions, which during the late 90s and early 2000s when those countries sought to join the alliance were collected through physical surveys of respondents, ranged from near neutral in former Czechoslovakia and Hungary to overwhelmingly positive in Poland and the Baltic States (Kostadinova, 2000; Mareš, 2000). Kostadinova (2000) notes that in the countries that historically had tenser relations with Russia, such as Poland and the Baltic States, NATO membership was also seen as a benefit as it filled the security vacuum left behind in the wake of the withdrawal of Soviet troops. Similar trends were observed in southern Europe, with Croatia being more neutral on the subject of joining the alliance while Albania, which had been without a major security partner since relations with the PRC soured decades earlier, was more eager to join NATO (Morelli et al., 2009).

Russian Security Policy and Views on NATO Enlargement

Russia and NATO have always had a contentious history, with alliance being founded to counter the Soviet Union, the direct predecessor state to modern Russia. Russian geopolitical thought views the world through a lens of zones of influence and power (Wolff, 2015). This way of viewing the world leads it to view any NATO enlargement as encroaching either on its zone of influence or the homeland itself. In addition, Russia's

actions in Ukraine during the lead-up to and initial invasion in 2014 show that it believes itself justified in intervening outside of its borders to protect perceived compatriots (Åtland and Kabanenko, 2020). In 2010, Russia updated its military doctrine to include NATO expansion as a primary threat to national security (Text of Newly-approved Russian Military Doctrine, 2010), a view that was reinforced by Minister of Defense Shoigu listing NATO expansion as one of the top three threats to Russia in 2013 (Russian Defense Minister Sees Terrorism, NATO Expansion as Main Threats, 2013). As time went on, relations continued to degrade and fear of NATO expansion reached a fever pitch in Russia, with one of the stated reasons behind the 2022 2nd Invasion of Ukraine being fear that the country would join NATO.

Chapter 4: New Sources of Geographic Data

With the rise of social media since the early 2000s, researchers have gained access to a wealth of new geographic data sources, particularly Twitter. Twitter's usefulness to geographers spans a broad range of geographic subdisciplines, ranging from studying human mobility to estimating flood water depth at a specific location based on geotagged imagery (Lin et al., 2020).

At its best, Twitter allows geographers to collect and analyze data at a more granular level than was possible before. Twitter's geotagging function in particular has proven useful for medical geographers, as seen in Castro et al. (2021)'s piece in which data from the microblogging website was used to help measure travel between sub-state level regions in Brazil to study potential Dengue Fever outbreaks.

Twitter also provides benefits to non-academic geographic researchers, particularly by acting as a source of volunteered geographic information (VGI) that can be used for open-source intelligence (OSINT) analysis. VGI sees many uses amongst the non-academic geographic community, though it has come to the forefront since the beginning of Russia's 2nd Invasion of Ukraine. Websites like Oryx (Oryx, 2023) utilize photographs shared on Twitter and other social media platforms such as Telegram, showing the destruction of military equipment by users involved in the conflict. These

photos are georeferenced using identifiable geographic features depicted in the images. This approach enables Oryx and similar platforms to establish a reliable baseline for estimating the minimum number of losses on both sides of the conflict. This proves invaluable not only for estimating total losses, of which geoconfirmed losses make up a small fraction, but also for tracking the locations of individual units during the war. The process involves cross-referencing tactical markings found on vehicles, providing valuable information ranging from the commanding unit to specific unit markings. These markings are then compared with known units that operate the same type of vehicles and are assigned under the parent command associated with those tactical markings. This careful analysis allows for accurate identification and attribution of the vehicles to their respective units and parent commands. VGI and OSINT have also been used to analyze damage from strikes on infrastructure and other static targets, as demonstrated by Pittet (2023)'s imagery of the Crimean Bridge in the aftermath of the attack by Ukrainian unmanned surface vessels on July 17th, 2023.

VGI also sees use by academic users who, much like their non-academic counterparts, use it for a wide range of purposes. Using image-based VGI posted to Twitter, and Twitter-like platforms, Lin et al. (2020) was able to accurately measure floodwater depth by analyzing the VGI using deep learning techniques to compare water surface heights against images of the same location taken during dry weather. Nguyen et al. (2016) used Twitter-hosted VGI to track how well neighborhoods throughout the United States were eating and how that affected their overall happiness by comparing

reported patronage of different eateries with sentiment scores linked to those neighborhoods.

Despite the many benefits that Twitter and other social media platforms have brought to geographic research, both in the academic and non-academic fields, there are many downsides to it. One such downside being raised by Crawford and Finn (2014, p. 493) who explain "… social media datasets only depict a specific time period, typically defined by the spike in Twitter messages or the use of particular hashtags…" and thus can only capture a small part of an overall event, particularly as many events have far reaching consequences that often go unstudied.

Twitter and its post promotion algorithms also have the potential to promote sensationalism on the part of users. This was noted by Vis (2013) when they observed how some news organizations and journalists use dramatic events to increase their follower count and their readership by amplifying the most eye-catching images and updates and Crawford and Finn (2014, p. 496) paraphrasing Papacharissi (2012) and Marwick and Boyd (2011) when they noted how "Twitter is used to pursue goals that go well beyond 'witnessing' an event. Twitter use is often described as performative, and this introduces a range of analytical hurdles…". This challenge of sorting out "click bait" type posts is hardly unique to the academic geographer community, with the OSINT community having to sort reposted or even faked footage of sensational events posted by certain accounts in an effort to draw attention to themselves.

These new forms of data offer many advantages over older forms traditionally used by geographers, such as census data and surveys. Monitoring social media allows for more dynamic tracking of opinion changes than surveys, which can be time consuming to write and administer. In addition, by studying social media posts, people can be observed interacting in a less guarded way than they might when interacting with a survey taker. The use of geotagging also allows for a far more granular study of human mobility than census data, as it allows for users to be tracked as they move about on a given day, while censuses are time limited and only record the respondent's residence. There can be disadvantages to these newer types of data though, as digitally uploaded records can have poorer quality than the originals, in addition to the aforementioned downsides of Twitter.

Sentiment Analysis

There are two main methodologies relating to sentiment analysis: machine learning based and lexicon based (Cortes and Vapnik 1995; Madhoushi et al, 2015; Alhumoud and Al Wazrah, 2021). Machine learning can either be supervised, which involves manually classifying and annotating a portion of the data to "train" the algorithm, or unsupervised, which involves allowing the algorithm to identify and classify data on its own without human input (Dahal, 2019; Mukhtar and Khan, 2019). Machine learning, while yielding more accurate results than lexicon-based analysis when used in its supervised form, does have major drawbacks relating to the need for training data and the time spent properly training the classifier to work when examining a new research topic (Xie and Wang, 2014; Alhumoud and Al Wazrah, 2021). Lexicon-based analysis, the

methodology to be used in this study, works by employing a dictionary-based lexicon to count the number of words coded as positive or negative in a piece of text and assign a score based on that number (Guha and Pande, 2021; Hossen and Dev, 2021). Lexicon-based analysis does have its own drawbacks, namely its inability to detect sarcasm or context specific vocabularies (Zimbra et al., 2018).

Sentiment analysis can be employed for a variety of uses, either as part of a larger study using additional analysis techniques or as a primary methodology. It has seen use in larger works relating to discussions of climate change, such as the study by Dahal et. al (2019) where it was employed alongside topic modeling and volume analysis to better understand not only how climate change was being discussed on Twitter but also what type of language (positive or negative) was being used in those discussions. Keeping with the use of sentiment analysis as a component of larger studies, it has also been employed to help understand differences in social media use between evacuated and non-evacuated populations during Hurricane Matthew in 2016 where it helped to determine that there were differences in long term sentiment between the two populations (Jiang et. all, 2019). Sentiment analysis is also used as a sole methodology, as will be the case in this study, to study public opinion for a variety of topics. In this role it has been used to study how PhD candidates view their educational experience (Guha and Pande, 2021) and to study political tweets centered around the 2018 World Cup in Russia (Meier et al., 2019). It has also been used to study sentiment in customer service interactions (Borg & Boldt, 2020), to examine spatiotemporal trends regarding public opinion on the COVID-19 vaccines (Hu et. all, 2021), and to compare how Indian and

Pakistani Twitter users' views differed regarding an incident in Kashmir (Rasheed et al., 2021).

Bots

Bots are a known issue with Twitter and are very hard to counter. With research showing that falsified news spreads faster than real news (Weng & Lin, 2022), much effort is spent on detecting and removing bots. Bots have been used to cause interference and spread misinformation on a variety of topics including discussions related to the COVID-19 pandemic (Weng & Lin, 2022), elections in the United States (Gorodnichenko et al., 2018; Weng & Lin, 2022), Germany (Keller & Klinger, 2019; Weng & Lin, 2022) and France (Ferrara, 2017; Weng & Lin, 2022). They were also employed extensively during the lead up to the United Kingdom's vote to leave the European Union (Bastos & Mercea, 2019; Weng & Lin, 2022). Bots see many uses on Twitter, but their most studied and controversial employment remains in the realm of information dissemination.

Bot detection, particularly on Twitter, is notoriously difficult due to the high heterogeneity that their profiles exhibit (Rovito et al., 2022) and the ability of their creators to adjust to the newest detection methods to evade bot hunters (Rauchfleisch & Kaiser, 2020). There have been great strides in detection tools, namely Botometer, which assess how similar an account's characteristics are to known bots (Varol et al., 2017; Weng & Lin, 2022), but even these aren't perfect. In particular, Fernquist et al. (2018) found that Botometer had difficulty with accurately identifying accounts that predominantly wrote in foreign languages such as Swedish. This is compounded by

human run Twitter accounts that appear to be bots at first glance, and their counterparts in bots that initially appear human (Rauchfleisch & Kaiser, 2020). Ultimately, bot detection is an ongoing challenge with no current solution.

Gaps in Literature

While there is a large corpus of literature relating to sentiment analysis, the same cannot be said for recent literature about Nordic security or Russia's position in the Baltic. Part of this can be said to result from the recency of the changing situation, with Sweden and Finland's security policy going from steady state to total change inside the typical publishing time of academic articles. There is also a dearth of literature relating to sentiment analysis specifically in a political geographic context. This paper will contribute to the existing body of literature on sentiment analysis and expand the currently available literature on using sentiment analysis for political geographic purposes.

Chapter 5: Methodology

This study sought to track the change in sentiment toward NATO by the netizens of Europe's two most militarily powerful non-NATO nations, Sweden and Finland. Sweden and Finland were chosen as the study area for three reasons: their imminent accession to the alliance, their military power within Europe, and the ending of their longstanding neutrality. The two countries' imminent accession to NATO was the main reason for choosing them, as their netizen's sentiment toward the alliance were comparatively more important to study compared to those of the smaller non-NATO European countries that are not joining the alliance. The rapid change in public opinion especially in light of their previous long held neutrality was also important to study as it allowed a near real time view of the changes necessary for the two countries' governments to make such a drastic change in their security and foreign policies. The other key reason Sweden and Finland were chosen is their military power within Europe; Finland and Sweden both rank highly amongst militaries in Europe in size and defense spending, well above several NATO members and by far the largest non-aligned (toward either Russia or NATO) militaries on the continent. A study of Europe's sole English speaking non-NATO country, Ireland, was decided against as it has such a small military and defense budget that NATO membership would be detrimental to both sides.

To study changes in sentiment toward NATO by Swedish and Finnish Twitter users, I used a collection of geotagged tweets by users in the two countries posted between June 1st, 2021 and June 30th, 2022 collected using Twitter's academic API. This date range was chosen to give a pre-invasion buildup baseline, go through the buildup leading up to the invasion, the invasion and NATO application process, through to a period during which the countries' accession was being ratified by the parliaments of NATO members. After the data had been collected, it was then translated into English using Facebook translation software. After translation was complete, further filtering for keywords and hashtags was done, and analysis commenced.

Defining Swedish and Finnish Twitter Users

This study defines "Swedish and Finnish Twitter Users" as those physically present in one of the two countries based on their geotagged tweets falling within their internationally recognized borders. The decision to focus solely on Twitter users physically present in the two countries rather than on their citizens, regardless of location, was made because accurately assessing if a user is a citizen of one of the countries based on information in their bio is impossible. Since users can put whatever information they want in their bio, location information may be omitted or untrue with no way to verify it without major privacy violations. Despite limitations arising from the inability to further quantify if users categorized as "Swedish" or "Finnish" actually identify with those labels, the aforementioned issue led to the determination that defining users as Swedish or Finnish based on their geotagged location would produce

the most accurate results based on techniques available to the author at the time the study commenced.

Data Filtering

After the Twitter data was acquired and translated, it was then filtered for keywords and hashtags relating to NATO. In order to reduce the chance of unrelated tweets making it through the initial filtering, only keywords and hashtags directly relating to NATO were used.

Table 5.1: A list of keywords/hashtags and the reasons they were chosen.

Keyword/Hashtag	Justification
#NATO	The name of the alliance in hashtag form. One of the most common denominators across all tweets discussing NATO in some form or another.
#OTAN	Organisation du Traité de l'Atlantique Nord. The most common acronym for NATO amongst the romance languages. Useful for picking out tweets in those languages and as it is also sometimes used in a diplomatic context.
#NONATO	Common hashtag used by those opposed to joining NATO.
#NATOLAKE	Refers to the concept of the Baltic Sea becoming a “NATO Lake” with the inclusion of Sweden and Finland in the alliance as, aside from the small segment of Russian coast in the Gulf of Finland, the Baltic would be entirely enclosed by NATO members. Began appearing in geopolitical discussions once the accession of the two countries began to be considered. Useful both for seeing how Swedes and Finns viewed their contribution to forming the “NATO Lake”.

NATO	The un-hashtagged name of the alliance. Useful for picking out discussions of the alliance that didn't use the aforementioned hashtags.

Data Analysis

The sentiment analysis process involved filtering the tweets and performing lexicon-based classification, specifically the VADER (Valence Aware Dictionary and sEntiment Reasoner) tool which has been specifically designed to study sentiments on social media (Hutto & Gilbert, 2014). VADER utilized a predefined dictionary of words associated with feelings and opinions, assigning scores ranging from -1 (negative) to 0 (neutral) to 1 (positive) to assess the sentiment of each tweet (Hutto & Gilbert, 2014; Alhumoud and Al Wazrah, 2021). VADER is noted for its great accuracy, with Tymann et al. (2019) stating "VADER reached great classification accuracy for microblogging platforms (up to F1 = 0.96) and was able to score better results than human raters in some cases". Additionally, efforts were made to identify and remove bot-generated content. This was achieved by examining the posting behavior of users, including factors such as post volume, (brief) content analysis (e.g., repetitive messaging versus analytical discussions), and subsequently eliminating bot-generated posts from the dataset. Although Botometer, a bot detection tool popular in academic studies, was tested, it returned inconsistent results and the hand sorting method outlined above was used in its place.

Following the initial sentiment analysis and bot filtering, the data was organized based on the province-equivalent level, which was chosen for two primary reasons:

clarity and commonality. The province-equivalent level was preferred for clarity since Twitter's geotagging mechanism occasionally assigned separate geotags to tweets originating from the same city, particularly in larger urban areas while assigning the same geotag to tweets originating from multiple smaller municipalities in rural areas. Aggregating data at a higher level resolved this issue. Moreover, the province level was selected due to its commonality, as it represented the lowest administrative level with equivalent divisions in both Sweden and Finland.

The subsequent phase of analysis involved examining the sentiment scores to identify temporal trends associated with changes in sentiment. This analysis aimed to establish any correlations between broader sentiment changes and specific events, such as the discovery of the Bucha massacre or the countries' NATO applications.

To cross reference the sentiment scores, public opinion polling relating to whether Sweden or Finland should join NATO was used. Public opinion polling was chosen for several reasons:

- Obtaining the desired cross reference data was a challenge. Instead of opinion polls about NATO in general, the author resorted to using polls on joining NATO. This was due to cost barriers and the author not knowing Swedish or Finnish as most of these poll results were only available in those two languages. Additionally, the questions' wording was such that free translation services often produced inaccurate translations.

- Sample size: opinion polling uses a larger sample size than other methods, such as reading letters to the editor, creating a more scientifically valid result.
- Survey periods: opinion polling is done relatively frequently, allowing for better validation of the study period and any changes in sentiment.
- Time constraints: due to time constraints necessary to complete this thesis, using validation data that required minimal additional processing was required.

It is important to note that public opinion is not the same as public opinion polling, or even the more dynamic sentiment analysis conducted in this paper. This is best explained by Zilberman and Webber (2003), who state that "[public opinion polls] do not equate public opinion – a dynamic process, with public opinion polls results – a static representation, a simplified snapshot of a complex phenomenon."

Chapter 6: Results and Discussion

After acquiring and cleansing the data of any non-related or bot-generated tweets, 10,685 were determined to be related to discussions of NATO as defined by the keyword list in the previous section. For a sample of 24 of those tweets and their sentiment scores, see table A.2 in Appendix A. The tweets were distributed in 452 unique locations across both countries, with 248 of those places being within the borders of Finland and the remaining 204 being within the borders of Sweden. Tweets were written in 29 different languages, with Swedish and Finnish being the most popular language used in their respective countries and English being the most common foreign language used in each country. Of particular note, many users with a high tweet volume were found to be affiliated with the defense, academic, or diplomatic communities.

Research Question 1

Overall, views of NATO remained neutral throughout the study period and did not change substantially even after Invasion Day. During the pre-invasion period of June 1st, 2021 to February 23rd, 2022, NATO was only mentioned 1,493 times: 599 by users located in Sweden and 894 by users located in Finland. There was an average sentiment score of -.01 across all tweets generated by users in the two countries. After the invasion, sentiment alternated between faintly positive and faintly negative in both

countries, with Swedish Twitter users trending more towards faint negativity while Finnish Twitter users trended more towards faint positivity.

Table 6.1: A summary of sentiment scores from the study period.

Month	**Average**	**Sweden**	**Finland**
Pre-Invasion	-0.01	-0.03	0.02
February (post invasion)	0.00	0.03	-0.03
March	0.00	-0.05	0.05
April	-0.04	-0.02	-0.05
May	0.01	0.00	0.01
June	-0.02	-0.02	-0.02

As seen in the table above, neither country trended strongly pro- or anti-NATO during the study period. The two countries also did not appear to react to significant events during the war, such as the discovery of the Bucha Massacre or Russian threats of retaliation for joining NATO, in a way that was measurable given the data available. The two countries also did not consistently trend the same from month to month regarding their views of NATO, only doing so in April and June when both countries held a very slightly negative view of the alliance.

Ultimately, Twitter users located in the two countries both remained neutral towards NATO during the study period, with national average sentiment scores remaining within a tenth of zero in either direction. Due to differences in tweet volume (discussed below), some regions had an outsized effect on their country's average sentiment score for a given month that resulted in scores not reflective of actual sentiments in that month. This is best reflected in public opinion for the month of May,

the last month of the study period for which polling is available, when 58% of respondents in Sweden (Novus, 2022) and 78% of respondents in Finland (Yle News, 2022) were in favor of their country joining NATO. If sentiment scores accurately reflected their countries' views toward NATO and joining it, assuming that polling showing 50% of respondents each supported joining/not joining NATO represented a sentiment score of 0.00, Sweden's sentiment score would have been approximately .13 rather than zero and Finland's would have been approximately .53 rather than .01. This is also in contrast to statements made by the Swedish (Basu, 2022) and Finnish (Gemensamt Uttalande Av Republikens President Och Statsministern Om Finlands Medlemskap I Nato, 2022) governments on NATO, which were strongly in favor of the alliance and joining it. These differences illustrate that Twitter users located within Sweden and Finland who geotagged their tweets were not representative of their countries' populations or their governments.

Sentiment on Twitter regarding NATO differed radically from public opinion polls conducted during the same period. On Twitter, opinion remained neutral and more closely mirrored views of the alliance held by nations such as the Czech Republic, Slovakia, Hungary, and Croatia in the lead up to their accessions to the alliance. This contrasted with public opinion, which was much more supportive and closely mirrored opinion in Poland, the Baltic States, and Albania during their own accessions.

Research Question 2

Spatial distribution of tweets favored the two countries' capitals and major population centers, with location relative to Russia not being a factor. In Sweden, this

saw users located in the metropolitan area around the capital city of Stockholm (comprising the Stockholm and Uppsala counties) and the Gothenburg-Malmö conurbation (comprising the counties of Västra Götaland, Halland, and Skåne) on the south-western coast producing 77.3% of all tweets sent during the study period. In Finland, this same trend saw the majority of tweets coming from the regions of Uusimaa, Pirkanmaa, and Southwest Finland which contain Finland's three largest cities of Helsinki, Tampere, and Turku respectively. These three regions combined to produce 72.9% of all tweets that originated from Finland during the study period, with Uusimaa, home of the capital city of Helsinki, producing 55.1% of them.

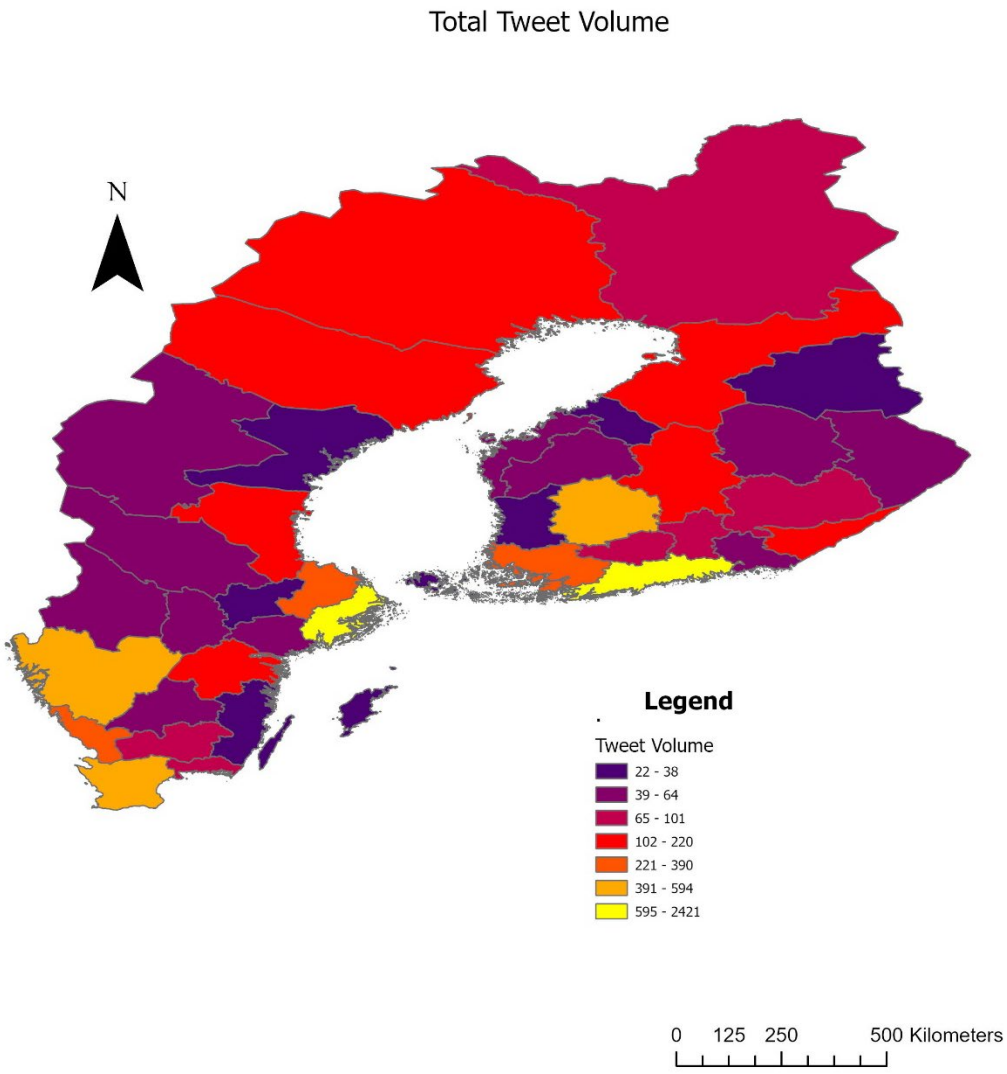

Figure 6.1: A map showing total tweet volume for both countries. The aforementioned regions are colored orange to bright yellow.

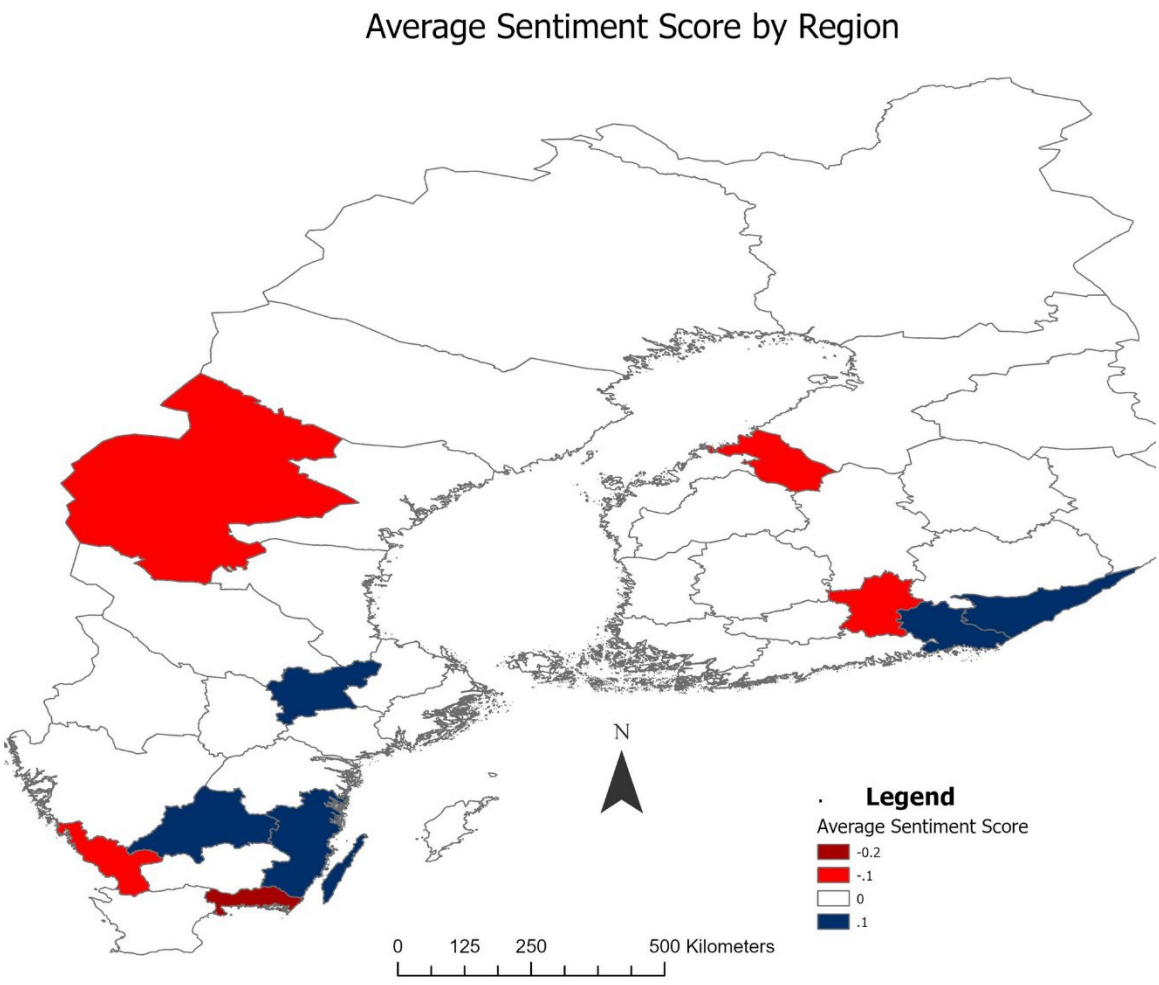

Figure 6.2: A map showing average sentiments across the entire study period.

As mentioned above, overall sentiment was very neutral. Of the 10,685 tweets studied as part of the dataset, only 2364, or 22.12%, were assigned a non-zero score. Of the two countries, Swedish Twitter users were the more "emotional", with 1,277, or 26% of tweets generated by users located in the country registering a sentiment score other than zero. In contrast, 1,087, or 19% of tweets generated by Twitter users located in Finland generated a sentiment score other than zero. Overall, these numbers speak to a less biased and more clinical discussion around NATO in the two countries.

While an urban-rural divide initially appears present in figure 6.2, this is not actually the case. Across both countries, a province-equivalent having a sentiment score further from zero was more an indicator of lower tweet volume in that location than anything else. This was due to the lower number of tweets making neutral tweets (with a score of zero) unable to average out tweets with a significantly higher or lower sentiment score. This phenomenon led to several province-equivalents in both countries with low tweet volumes having sentiment scores that differed from those of their counterparts with significantly higher tweet volumes and the national average of zero for both countries.

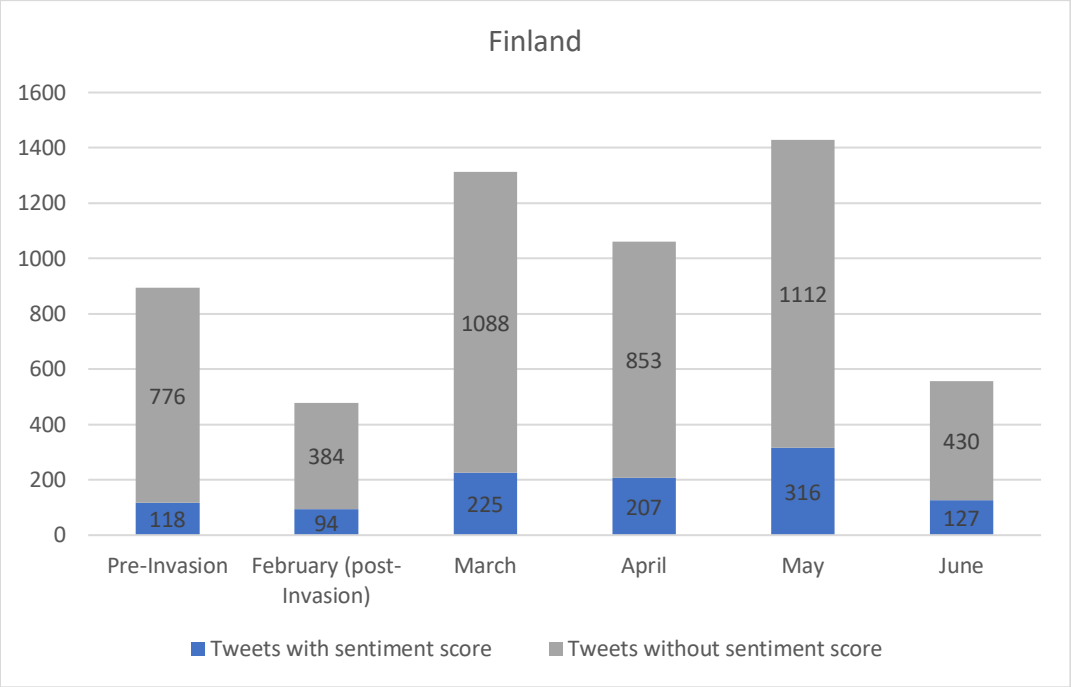

Figure 6.3: Bar chart showing numbers of tweets with and without sentiment scores originating from Finland.

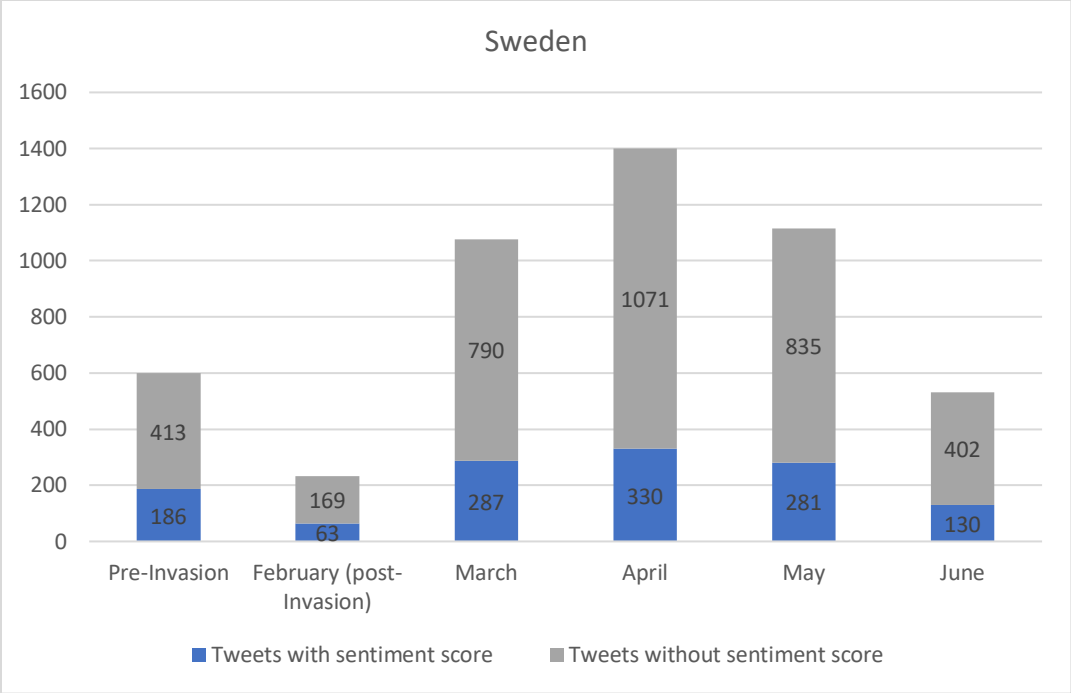

Figure 6.4: Bar chart showing numbers of tweets with and without sentiment scores originating from Sweden.

A temporal trend regarding discussion of NATO was very clear in both countries' data. In the time from June to October of 2021, the alliance is discussed very little and almost exclusively in a neutral way. As Russia commenced with its pre-invasion military buildup, discussion began to increase, but remained sparing and with low numbers of tweets assigned a non-0 sentiment score. In total, the entire pre-Invasion tweet volume only equated to one month of post-invasion tweet volume. After the 2nd Russian Invasion of Ukraine began on February 24th, 2022, discussion increased significantly to a pace that remained consistent until June, when discussion began to die down in the wake of the two countries' NATO applications being submitted.

Research Question 3

Tweets in foreign languages, defined here as languages other than Swedish in Sweden and Finnish in Finland, accounted for 1955, or 18.3% of all tweets used in this study. They were written in 29 different languages, with English being the most common foreign language in each country. Sweden had a higher percentage of foreign language tweets, at 19.41% of total tweets originating from that country compared to 17.3% of those originating from Finland.

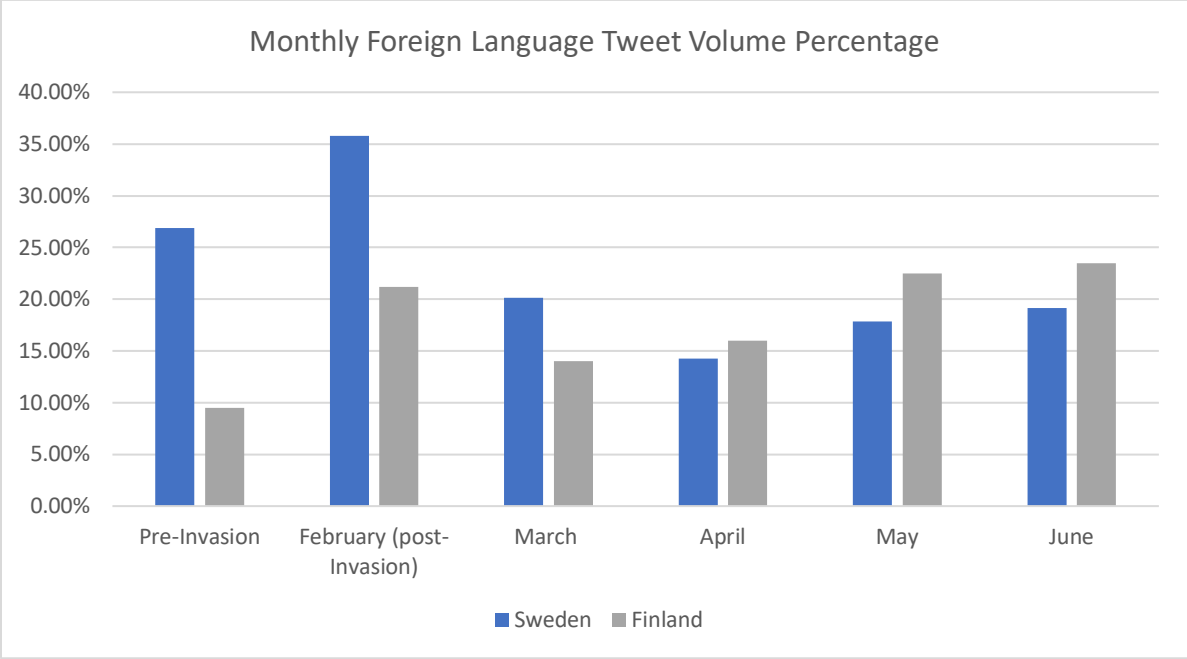

Figure 6.5: A comparison chart showing the percentage of monthly tweet volume in foreign languages for each country.

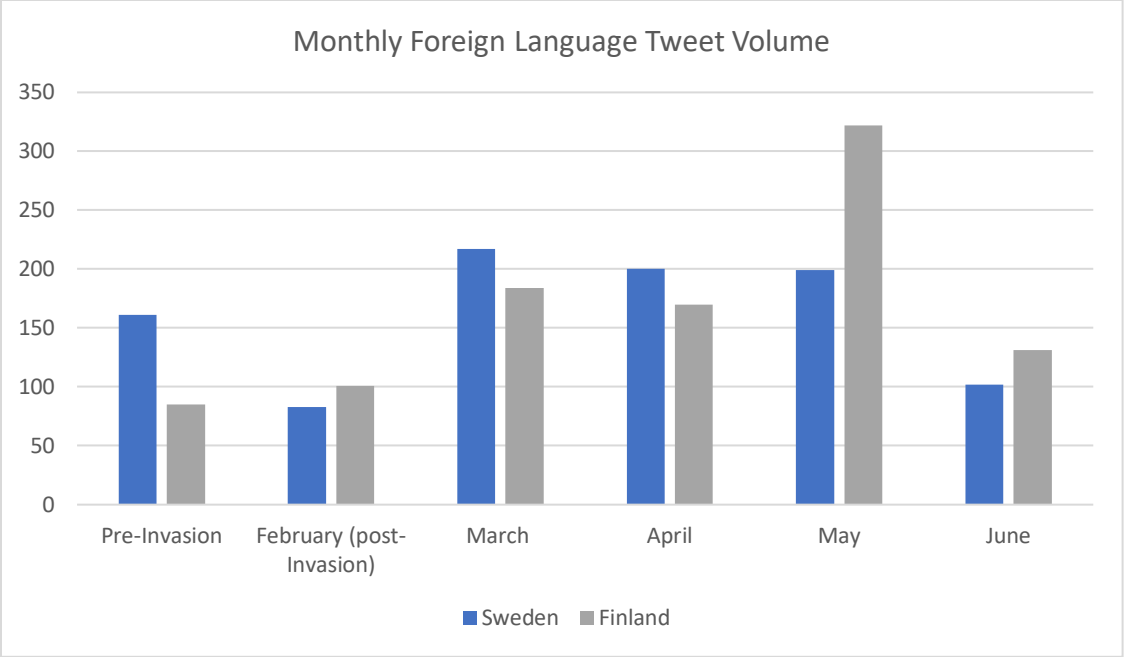

Figure 6.6: A comparison chart showing the total monthly tweet volume in foreign languages for each country.

As seen in Figure 6.5, Sweden initially had a higher percentage of foreign language tweets than Finland, though this trend was reversed in April and later months. What is notable is that the percentage of foreign language tweets discussing NATO declines in Sweden in the time after the invasion, while Finland sees progressively higher percentages each month following the invasion. This is in contrast to the less consistent trends in raw foreign language tweet volume shown in Figure 6.6, which saw Sweden produce more foreign language tweets than Finland (barring invasion-shortened February) until May. The trends relating to percentages are explainable in the context of there being more Non-Governmental Organizations located in, and thus tweeting from, Sweden. As time went on and the prospects of the two countries joining NATO increased, defense writers in Finland began writing more in other languages in an

effort to make the debate over NATO membership more accessible to the rest of the world. The uptick, both in terms of percentage and in terms of raw tweet volume, seen in May corresponds with the two countries submitting their applications to the alliance.

In terms of sentiment, foreign language tweets from both countries deviated from the average sentiment of tweets in the national language. In both countries, sentiment averaged at zero every month during the study period, while foreign language tweets varied in average sentiment between .1 and -.1. These variations came about not necessarily due to differences in content between foreign language and national language tweets, but rather due to differences in tweet volume allowing smaller numbers of foreign language tweets with a sentiment score other than 0 to affect averages to a greater degree than possible with the larger numbers of national language tweets.

Bots

Handling bots was a key, although surprisingly small, component of this study. In total, 6 bots were detected, accounting for 1,536 total tweets. Four bots were classified as pro-Russian based on the content of their tweets being primarily retweets of Russian talking points or pro-Russian messages. Two bots were classified as being pro-Ukrainian for similar reasons, albeit with pro-Ukrainian talking points and messages. Four of the bots were located in Sweden and two were located in Finland, operating out of the capital cities of each country. Bots were found to generate tweets with sentiment scores closer to 1 or -1 than average which, combined with their typically high tweet volume and tendency toward repeating the same message, made their detection significantly

easier. The low number of bots does not have a clear explanation, although the use of geotagging in this study is believed by the author to have played a role in limiting their number.

Chapter 7: Conclusion

This study conducted a sentiment analysis of Twitter users located in Sweden and Finland who enabled geotagging of their tweets to determine their sentiments towards NATO, the North Atlantic Treaty Organization, during the period between June 2021 and June 2022. It was conducted to measure how sentiment toward NATO in those countries shifted in response to Russia's 2nd Invasion of Ukraine on February 24th, 2022. The study found that most tweets sent during the study period came from the major population centers of the two countries and were very neutral in sentiment, not matching public opinion polling in either country. It was also found that while very little discussion of NATO took place before the invasion began, post invasion discussion volume increased and remained constant month over month until after the two countries had submitted their applications to the alliance.

This study was significant for several reasons. It provides a contribution to sentiment analysis literature not only regarding the methodology's use for studying political events, but also for using it on non-English language source data is perhaps the most important. The chance to see what a (admittedly small) portion of the publics in both countries thought of NATO in the lead up to their applications to the alliance at a more granular level than normally possible was another significant contribution. This study's contributions, in addition to their use in the academic sphere, have foreign

policy implications not only because of its subject matter and results but also because it illustrates the potential that sentiment analysis has as an analytical tool for government agencies and non-governmental organizations.

Limitations and Future Work

This study did have a number of limitations. The greatest was the lack of native speakers (or even just speakers) of Swedish and/or Finnish who could have helped with translating the tweets instead of the need to rely on machine translation. It is suspected that the data was skewed by the tendency of machine translation to be very flat and unemotional. This likely made sentiment scores skew slightly more neutral than it would have been had native speakers more familiar with the nuances of each language been able to assist with the translation.

Another limitation was the need to use geotagged tweets. While that was quite obviously essential for confirming that the data did come from users located in Sweden and Finland, in addition to rooting the study in the discipline of Geography, it did limit us to those that geotag their tweets. As mentioned in the results section, this led to an overrepresentation of those in the defense writer community and a very neutral discussion overall. This did have the benefit of limiting bots' presence in the dataset though, since it's more time consuming to fake a bot's location and generally less likely to be done.

The final limitation was that this is a master's level thesis focused on the technical aspects of how Twitter users located in Sweden and Finland viewed NATO. As a necessity, the project was limited by time constraints, my skillset, and the need to

keep the scope of the project limited, which left it unable to explore in depth other topics, such as what topics were discussed in the data or etymological questions regarding how nations are referred to. In addition, collaboration with others was limited to assistance with data collection and processing. Without those constraints, further analysis such as topic modeling could have been done with the assistance of collaborators with other areas of expertise.

This study has a great deal of potential for future work. Even just removing the limitations mentioned in the paragraph above and working with a team using the same data could result in a different study than this one. In addition, increasing the period studied to the current time may have interesting results, as we are now at one year from Sweden and Finland submitting their applications to NATO and Finland is now a member while Sweden's application still requires ratification by several parliaments.

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Appendix A: Additional Maps and Tables

Table A.1: Samples of tweets from both countries collected throughout the study period.

Date	Translation	Sentiment Score	Country of Origin
2/1/2022	If it unbelievable happens that Russia attacks Sweden, the United States (NATO) would rush in with immediate effect; not first and foremost to save Sweden; but to save itself.	0	Sweden
1/13/2022	and think when uif nuclear power plants began to pop up here in Sweden; what NATO would like sveriges free contribution iaf;uif a non-NATO membership at least leads to more modern nuclear power&energy technologies!	0.126	Sweden

1/17/2022	The majority of the Finnish people are opposed to NATO; although the last month has been stumbled in the media of fear of Russia.	0	Finland
1/3/2022	Itâ€™s exciting; how the same faces that repeat vaccination responsibility etc. are opposed to NATO membership ðŸ˜,	0.4404	Finland
2/27/2022	Now only one thing is missing: NATO membership	0	Sweden
2/24/2022	None of these countries would be remotely interested in NATO membership if they were not pointed out and directly threatened by Russia. Where would the 3 Baltic states be today without membership?	-0.0772	Sweden
2/24/2022	I am disappointed with President NiinistÃ¶Ã¶. he seems to be on the same continuation with his predecessors and does not dare	0	Finland

	to make a crucial security decision for our country, namely to join NATO.		
2/24/2022	â€œWe were joined today by our close partners Sweden; Finland; and the European Unionâ€ - #NATO Supreme Allied Commander Gen. Tod Wolters.	0.5574	Finland
3/8/2022	When the European Parliament votes for a resolution that in principle says that the EU and NATO are the same thing, it is difficult not to understand that Russia also sees them as about the same thing.	0	Sweden
3/14/2022	In a video address released shortly after the midnight; Ukrainian President Volodymyr #Zelenskyy said: "if you don't close our sky; it's only a matter of time before #Russian rockets fall on your territory; #NATO territory"	0.0258	Sweden

4/13/2022	Team BaBu starts NATO discussions in Finland and Sweden	0	Sweden
4/30/2022	Ukraine. This is a message for you. You need to say NO to NATO. VictoryâœŒï¸ for the Sovjet UnionðŸ‡·ðŸ‡º	0.0688	Sweden
5/16/2022	I tell you, Putin field, Hamidan thinks Sweden like UkraineðŸ‘Œ Arab urgent/ Putin threatens to respond to NATO expansion in Finland and Sweden #Arab urgent - through the pulse application	0.7297	Sweden
5/14/2022	Maybe Erdogan stops worldwar with his action. PM Andersson said in mars that we're not to join Nato cause it deteriorating security in the area. She was rigth but I think she's being pressued to rethink. #NejTillNATO	-0.0114	Sweden
5/17/2022	This, in my opinion, does not answer that question; that how would the	0	Finland

	NATO cease to exist; if the United States was not a member of it. There is there then any rule-based reason? The full "West Bank" (FR and GB) received material or other military aid did not disappear; even if the United States would disappear?		
5/4/2022	â€œThe security of the Finnish people will significantly improve; if they join NATO; as if they are frozen outâ€ #turpo #NATO #assembly #targrid	0	Finland
6/29/2022	* Turkey? ** Cyprus? *** Syria? **** Exceptions: NATO Members	0	Sweden
6/4/2022	â€œIf you stop Finland and Sweden entering NATO weâ€™ll let you do whatever you like with the kurds in northern Syriaâ€ probably was Putinâ€™s deal with Erdogan.	0.0772	Sweden
6/14/2022	#Turkey is alleged in buying Ukrainian grain	-0.1779	Finland

	stolen by Russians; has thrown a wrench into Sweden and Finland's bid to join the NATO; lashed out at NATO-ally Greece and announced plans for a new incursion into Syria. : is Turkey today really the partner you want to have?		
6/3/2022	#Turkish and #Germany; one just from Finland and Sweden to a terrorist state and blocked #NATO membership. the other will do everything in its way to push for #Ukraine to provide weapons assistance. its own interest; there is not much about the security of a few countries; or the country that is attacked by a war pressure.	0	Finland

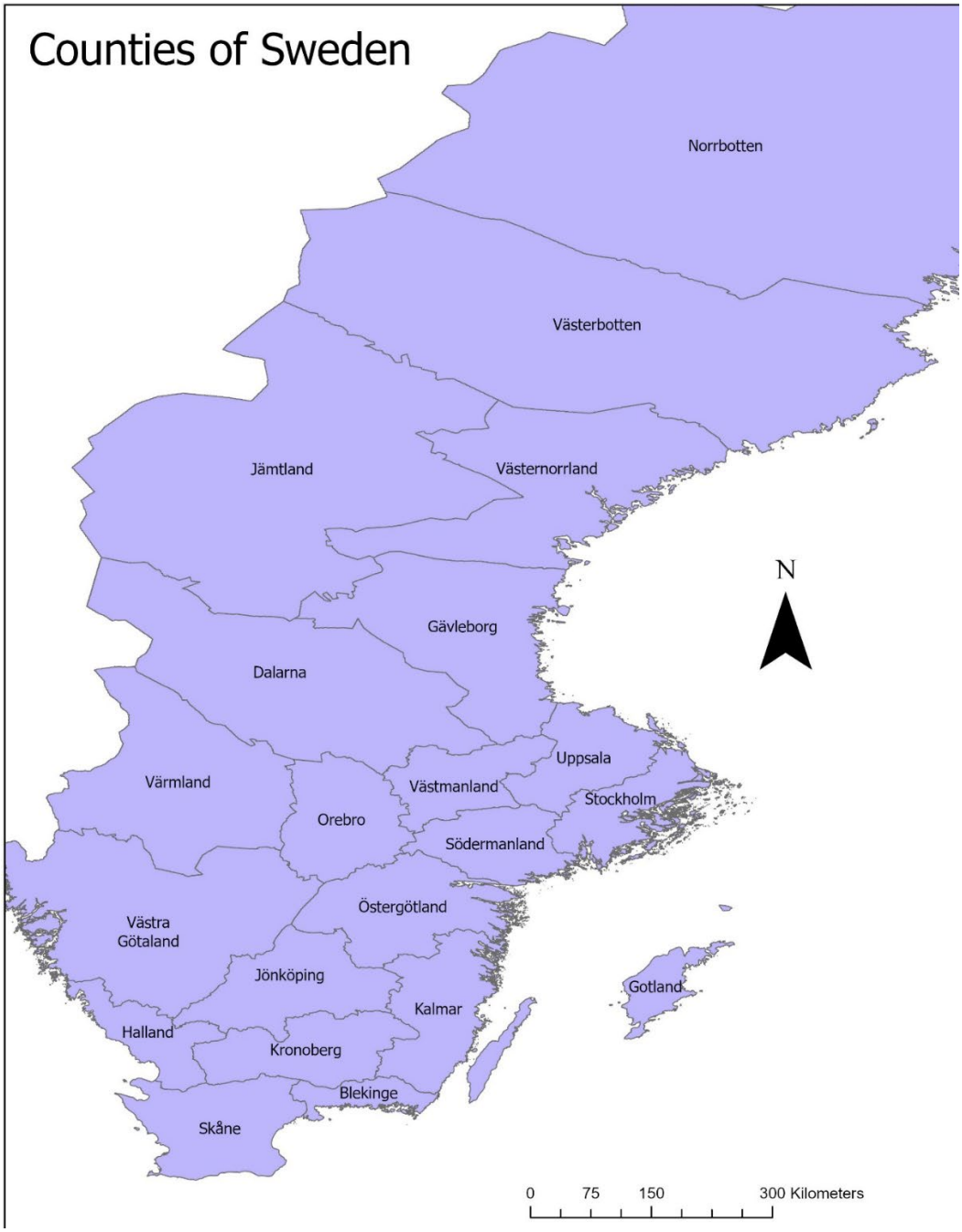

Figure A.1: A reference map of Sweden's Counties

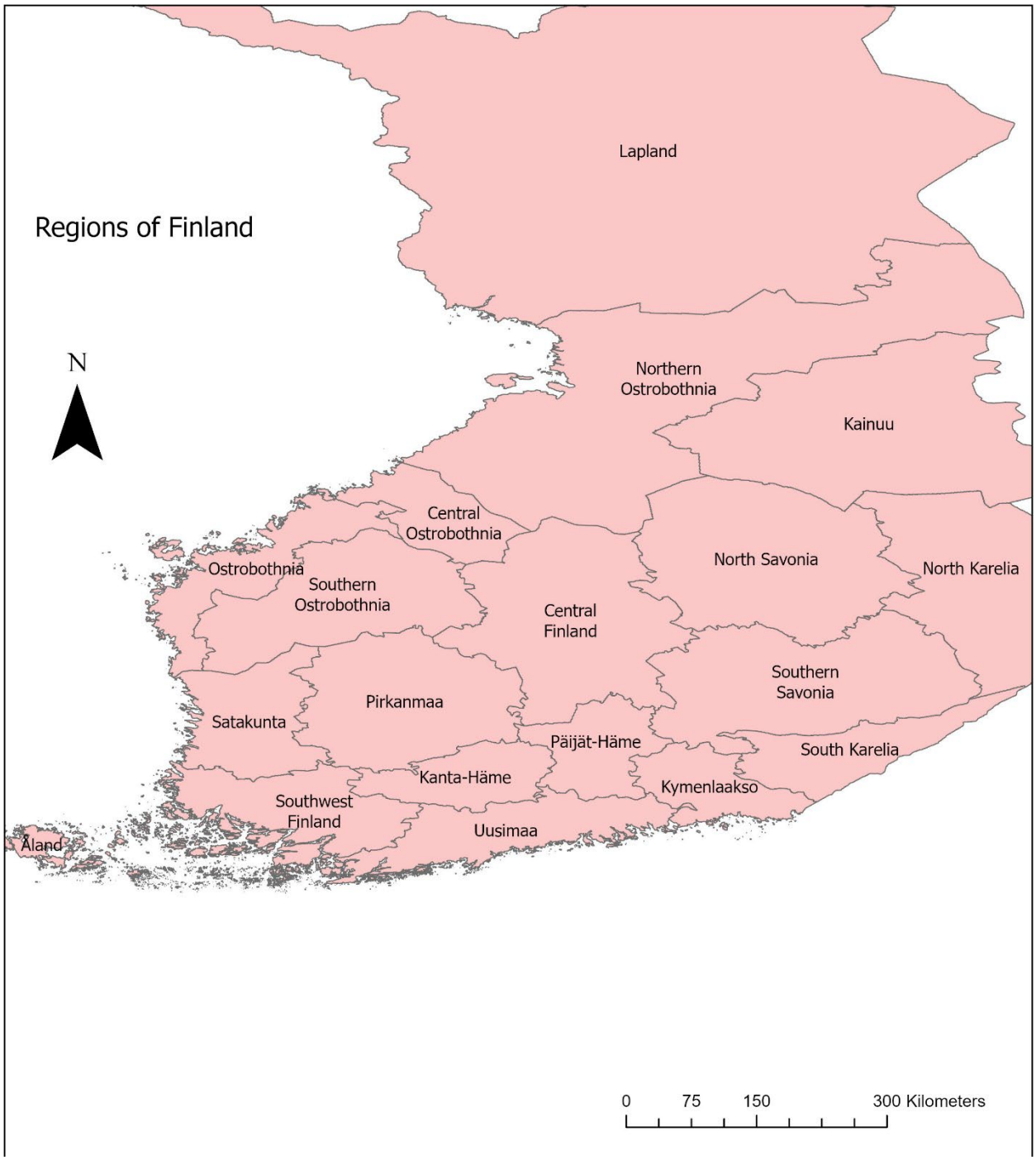

Figure A.2: A reference map of Finland's Regions

Table A.2: A reference table of every region studied, its tweet volume, and average sentiment over the entire study period.

Region	Region Total Tweet Volume	Region Average Sentiment
Åland	30	0
Blekinge	101	-0.2
Central Finland	164	0
Central Ostrobothnia	43	-0.1
Dalarna	44	0
Gävleborg	158	0
Gotland	32	0
Halland	284	-0.1
Jämtland	44	-0.1
Jönköping	42	0.1
Kainuu	44	0
Kalmar	22	0.1
Kanta-Häme	86	0
Kronoberg	89	0
Kymenlaakso	55	0.1
Lapland	133	0
Norrbotten	125	0
North Karelia	62	0
North Ostrobothnia	285	0
North Savonia	83	0
Orebro	62	0
Östergötland	122	0
Ostrobothnia	73	0
Päijät-Häme	112	-0.1
Pirkanmaa	632	0
Satakunta	32	0
Skåne	541	0
Södermanland	41	0
South Karelia	146	0.1
South Ostrobothnia	72	0
South Savonia	131	0
Southwest Finland	392	0
Stockholm	2023	0
Uppsala	390	0
Uusimaa	3154	0
Värmland	59	0

Västerbotten	121	0
Västernorrland	38	0
Västmanland	24	0.1
Västra Götaland	594	0