Exploring Traces of Controversies and Major Company Events on X (Twitter) Reviews In The Google Play Store

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Abstract

This paper investigates the traces of controversies and major company events in user reviews within the Google Play Store, specifically focusing on app reviews from X (Twitter). The focus of the reviews are from the year of 2020 to 2023, where events such as the American election, Ukraine Russia war, Israel Palestine conflict, and Elon Musk's acquisition of Twitter occurred. Leveraging topic modeling techniques, we discover that X (Twitter) app reviews in the Google Play Store include traces of a few of these events.

1 Introduction

The rise of social media applications has significantly altered the dynamics of the modern society, with these applications becoming a crucial tool in order to stay in touch with the modern world. Within this paradigm, applications such as Instagram, Facebook, Tiktok, and X has emerged, influencing and reflecting public sentiment on diverse events across the globe. While the influence of these social media application is ever increasing, the controversies with these application is also increasing. Issues such as Facebook's Cambridge Analytica data scandal (Confessore, 2018) and Tiktok's data security (Maheshwari and Holpuch, 2023) resulted in events such as congressional hearings or even application bans.

In "User Feedback in the App Store: A Cross-Cultural Study" (Guzman et al., 2018), evidence was found about the influence of cultural factors on characteristics of app reviews. In the landscape of mobile applications, user reviews serve as insights for companies and new users, reflecting past user experiences, preferences, and sentiments. Outside influences such as cultural differences display traces of influence in app reviews, therefore, we wondered if company or external controversies and events related to social media platforms would have similar effect.

This paper aims to explore traces of influence from global controversies and company events on the content of social media app reviews through topic modeling methods. With the growth of the internet, controversial events or actions of a company spread quickly and may instigate unforeseeable backlash, resulting in events such as bans or mass boycotting. Through understanding the impact of external factors on user sentiments, developers, marketers, and researchers can synthesize strategic decisions to prevent further conflicts, enhance user engagement, and experience. In addition, studying the dynamics between external events and user reviews can also contribute to understanding the relationship between technology, user perceptions, and societal events.

2 Background

This study will utilize Latent Dirichlet Allocation (Blei et al., 2013) and BERTopic (Grootendorst, 2022) topic modeling techniques to discover traces of controversies and major company events in user reviews of X (Twitter). To provide a focused examination, we narrow our lens to the years 2020 to 2023, a period marked by globally significant occurrences, including the American election, the Russian Ukraine invasion, the Israel Palestine war, and high-profile acquisition of the platform X (Twitter) by Elon Musk. By concentrating on this time frame, we aim to capture the shift in topics included in user reviews amidst a backdrop of societal and corporate upheavals. The specific choice of X enhances the relevance and specificity of our investigation, as many of these events were directly discussed or even debated on the platform.

LDA uses a probabilistic approach by making the assumption that each document contains multiple topics, and each word in the document is attributable to one of these topics. It is used in areas such as Software Engineering, Social Networks, Linguistic Science, and more (Daud et al., 2010) due to its simplicity and interpretability. However, LDA is unable to capture intricate semantic relationship and contextual nuances. It also does not consider the word-order of the document. BERTopic on the other hand, utilizes transformer-based language model BERT (Devlin et al., 2019) to embed words and documents into high-dimensional vector spaces. Unlike LDA, BERTopic is able take the contextual information and semantic nuances of words in consideration. By applying both LDA and BERTopic topic modeling techniques, we are able to provide different perspectives on the user reviews: one considering sentiments, one simply considering word occurrences.

There have been various studies on the relationship between app reviews and score, review sentiments, and opinion mining. However, to the best of our knowledge, there seems to be few to none analysis on the effect of controversies on social media applications and its app reviews. The closest thing that could be found was "User Feedback in the App Store: A Cross-Cultural Study" (Guzman et al., 2018), a study on possible cultural influences in app reviews.

3 Data and Method

The dataset for this paper was gathered from "2 Million X (Formerly Twitter) Google Reviews" (BwandoWando, 2023), found on Kaggle. The dataset contained over 2 million entries of user reviews and ratings with review submission dates ranging from 2010-04-30 to 2023-11-14. For the goal of this project, only user reviews from year 2020 to 2023, a total of 5705976 reviews were utilized. All reviews were in the language of English, although with inclusion of spelling mistakes or slang.

Before performing topic modeling, we pre-processed the review texts using Spacy, converting each word to its stem form. Then we removed any stop words from the reviews. For the purpose of stop words removal, the stop word list predefined by Spacy's en_core_web_sm module was utilized. Outside of stop words, we also removed words that were not a noun, adjective, adverb, or verb. This resulted in some rows of empty reviews which were removed from the dataset.

Applications in the Google Play Store often display popups for users to rate their app while users is using the app. This results in many reviews containing few uninformative words such

as "good" or "nice". The influence of these reviews were also short, uninformative reviews were evident when we tested our original LDA and BERTopic models. Therefore, we decided to remove reviews with resulting words less than 5. Through this removal, we hoped to focus on more informative reviews. The result of this was a significant decrease in the number of reviews, with 53455 reviews for 2020, 62427 reviews for 2021, 47866 reviews for 2022, and 49186 reviews for 2023 left.

Following pre-processing, we first performed simple analysis on each year, finding the average number of words, characters, and top words. Then for every year from 2020 to 2023, we trained a trigram LDA model with Gensim and a BERTopic model. For the LDA models, we performed hyper-parameter tuning with the number of topics, constrainted to the range from 3 to 9. We chose the model with the highest coherence score as the best model. Finally, we visualized the top words that contributed to each topic.

For detailed implementation, please view the following notebook.

4 Results and Analysis

For the year 2020, 2021, and 2022, the LDA models had the highest coherence score with 3 topics, displayed in Figures 5, 6, and 7 respectively. Meanwhile, the LDA model for reviews from 2023 had the highest coherence score with 9 topics (Figure 8). In contrast to the LDA models, the BERTopic models resulted 8 topics for all 4 years.

The resulting topics from LDA models for reviews from 2020 to 2022 were relatively similar compared to the year 2023. However, the words in these topics were mostly words from the top 25 frequent words in each year (Figures 1, 2, 3, 4). In general, the topics selected by LDA did not seem to contain much influence from company events or external controversies. The closest results were words such as "Speech" and "Freedom" in 2022 (Table 3) and 2023 (Table 4).

The resulting topics from BERTopic models contained with references to both company events and worldwide controversies. The BERTopic model for 2021 had topics with words related to pornography. When cross referencing with real events that happened in the world, we found that Twitter indeed had controversies with child pornography in 2021. In 2021, Twitter was sued by two minors when Twitter "refused to remove child porn because it didn't violate policies" (Fonrouge, 2022). Twitter's specific argument was that "it did not participate in the venture, and that even if it had, it gained no benefit" from the participation (IOVINO, 2021). This argument was eventually overruled in 2021, after which more and more lawsuits regarding child pornography were filed against Twitter (Jazeera, 2021).

The 2021 BERTopic model also resulted in a topic of "Palestine", "Israel", "Zionist", "Israeli", and "Gazaunderattack" (Figure 10). Similar with child pornography, we also searched for related events. Unsurprisingly, In the year of 2021 there was indeed a conflict between Israel and Palestine. In 2021, the Supreme Court of Israel had ruled in favor of evicting several Palestinian families from East Jerusalem properties, resulting in eruption of protests. The protests then eventually escalated to missiles fired by the militant group Hamas who governs Gaza into Israeli territory, which Israel responded with its own airstrikes (for Preventive Action, 2024). With regard to Twitter's involvement in this conflict, Twitter acted as a ground for global discussion, resulting in clashes of different opinions and the rise of threats (Scheer, 2021), misinformation, and hate speech (League, 2021).

Outside of the 2021 BERTopic model, the only year that also had traces of external events was 2022, where a topic was found referencing Elon Musk(Figure 11). This of course, references Musk's high profile initiation and completion of acquisition of Twitter 2022. In April 2022, Elon Musk initiated an acquisition deal with Twitter. This deal was then put on hold after Musks' various promises to improve the platform by removing "bots" and promoting "free speech". After a period of back and forth arguments between Musk and Twitter, Musk finally completes the acquisition on Oct. 28. After the acquisition, Musk made many controversial actions such as immediately firing previous executives, laying off half of the workforce, and creating a subscription service for verification (Zahn). Not only is this event directly related to Twitter as a company, it also served as a platform for related parties such as Musk, past executives, or even lay-offed employees to communicate and discuss their thoughts.

Through cross examining historic events with the topics found by our BERTopic models, it appears that there are indeed traces of major company events and external controversies in user reviews for X. It is important to note that these traces not only appears for directly related events, but also events indirectly related to the company. However, it is noteworthy that not all significant events manifested as distinct topics within the topic model. Surprisingly, other events of global significance, such as the COVID-19 pandemic, the U.S. presidential election, and the Ukraine-Russia war, did not yield discernible topics within the Twitter reviews. This absence may suggest that certain controversies or events despite their global significance, might not have a direct influence on user sentiments to the point of effecting application reviews, or their influence may be more complex and indirect.

5 Conclusion

By employing advanced topic modeling techniques, including Latent Dirichlet Allocation (LDA) and BERTopic, we sought to explore traces between external events and user reviews for social media applications. Our findings reveal a discernible trace on user reviews during major events such as the 2021 Israel-Palestine conflict, Twitter's child pornography controversy, and Elon Musk's high-profile acquisition. The emergence of these distinct topics reflect the significance of these events on the application's users.

This study contributes insights into the intricate relationship between external events and user reviews with regard to social media applications. The identification of influence of direct and indirect events on user sentiments provides a better understanding of the dynamics between users and social media. As technology and societal landscapes continue to evolve, this research provides a foundation for future investigations into the complex dynamics that effects user perceptions and behaviors within the expanding digital world.

Appendix

topic	Top words
Topic 1	Account, Twitter, Time, Try, Suspend
Topic 2	App, Good, People, Use, Great
Topic 3	Tweet, Update, Work, Fix, New

Table 1: LDA topics for 2020

topic	Top words
Topic 1	App, Good, Use, People, Like
Topic 2	Account, Tweet, Update, Time, Fix
Topic 3	Claim, Hate, Fake, People, Ban

Table 2: LDA topics for 2021

topic	Top words
Topic 1	Account, Speech, Free, Suspend, Freedom
Topic 2	Tweet, Update, Try, Time, Take
Topic 3	App, Gpod, Twitter, Number, Well

Table 3: LDA topics for 2022

topic	Top words
Topic 1	Account, Bad, Time, Try, Want
Topic 2	Video, Nice, Twitter, Get, Need
Topic 3	App, Good, Great, X, Love
Topic 4	Take, Suspend, Star, Awesome, Amazing
Topic 5	Social, Medium, People, Thing, Content
Topic 6	Well, Thank, Lot, Able, Bias
Topic 7	Platform, Post, Experience, Load, Day
Topic 8	Speech, Free, Update, New, Go
Topic 9	Freedom, Change, Like, Use, News

Table 4: LDA topics for 2023

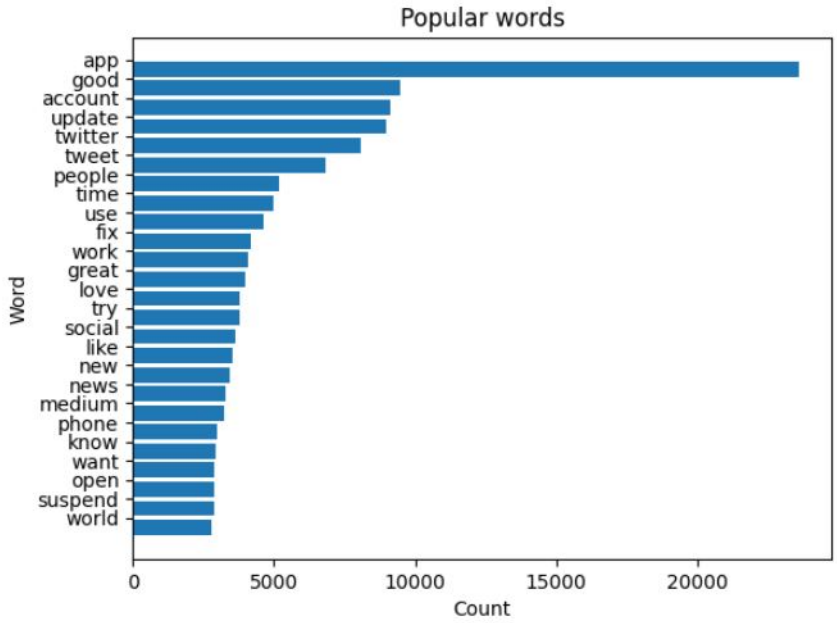

Figure 1: Top words in reviews 2020

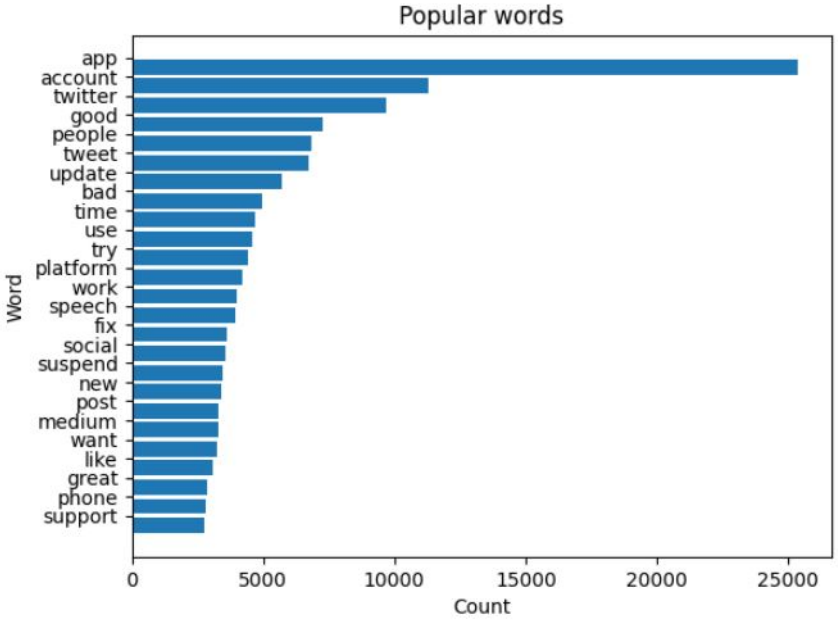

Figure 2: Top words in reviews 2021

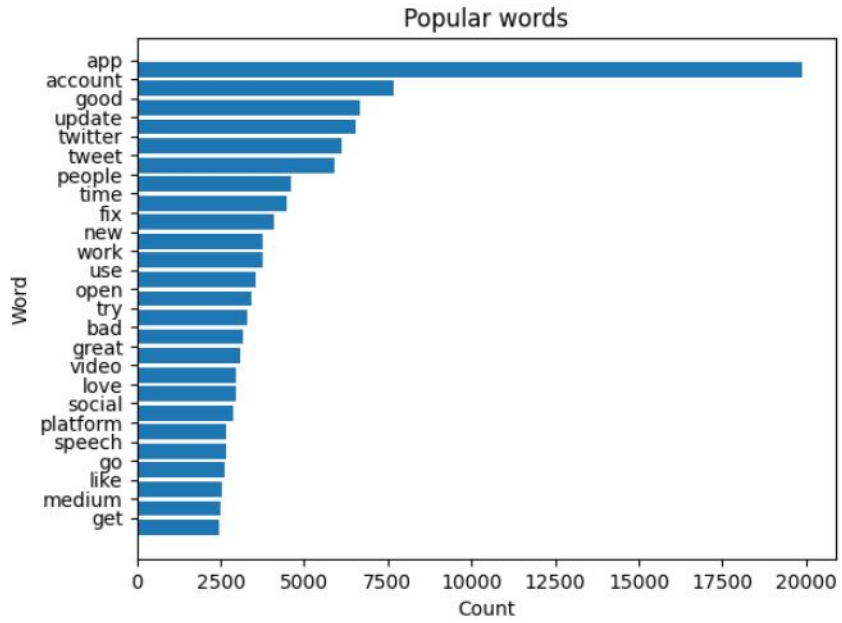

Figure 3: Top words in reviews 2022

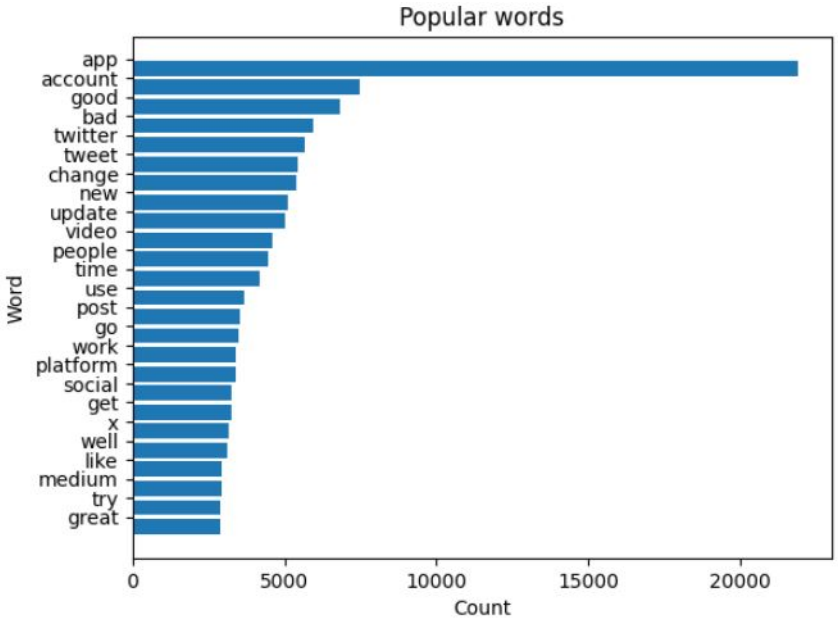

Figure 4: Top words in reviews 2023

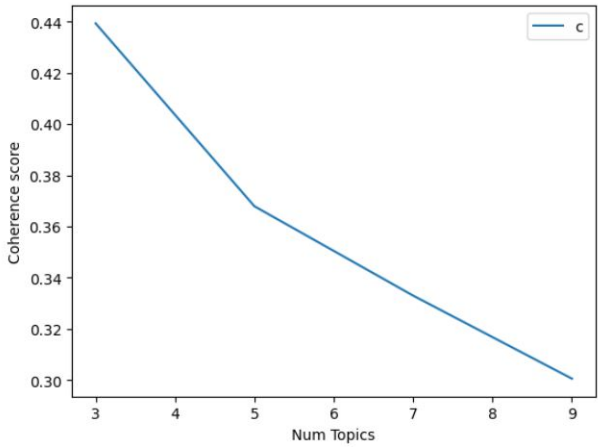

Figure 5: LDA Coherence scores for 2020

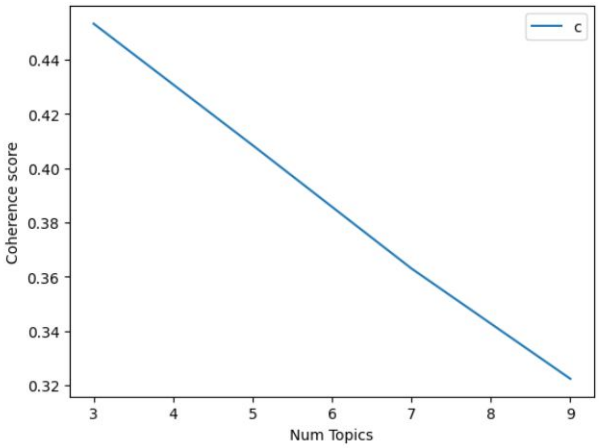

Figure 6: LDA Coherence scores for 2021

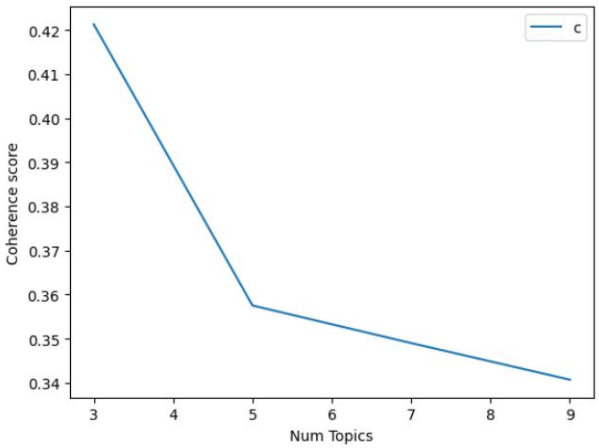

Figure 7: LDA Coherence scores for 2022

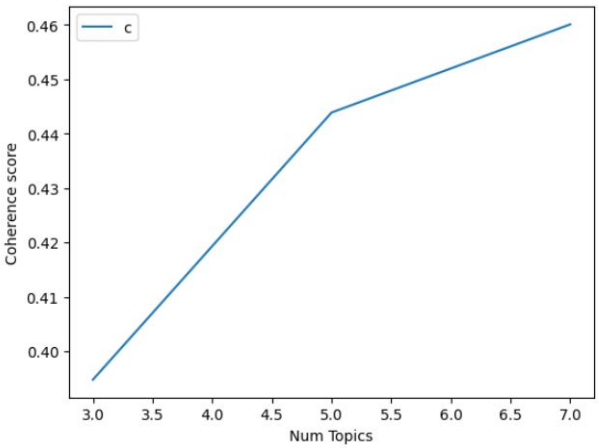

Figure 8: LDA Coherence scores for 2023

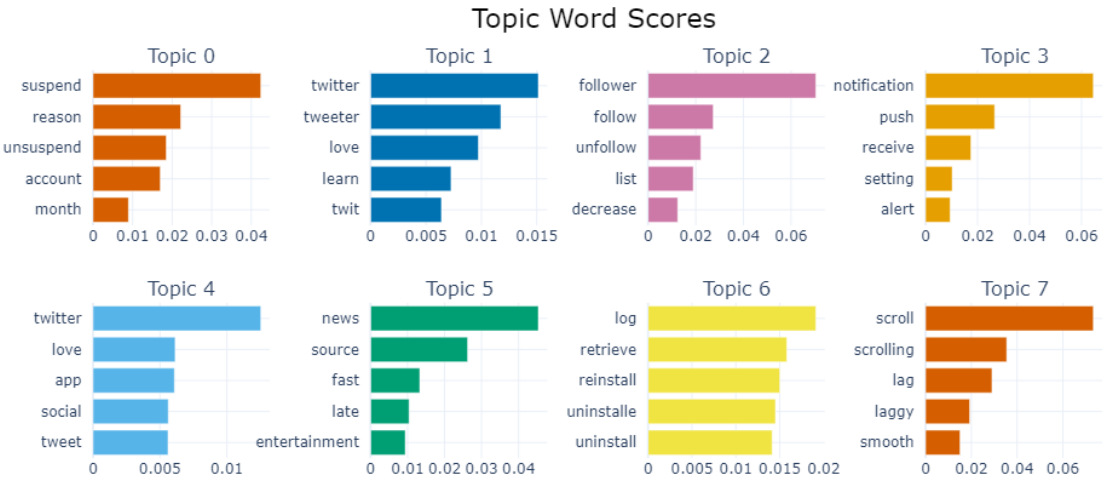

Figure 9: BERTopic topics and top words for 2020

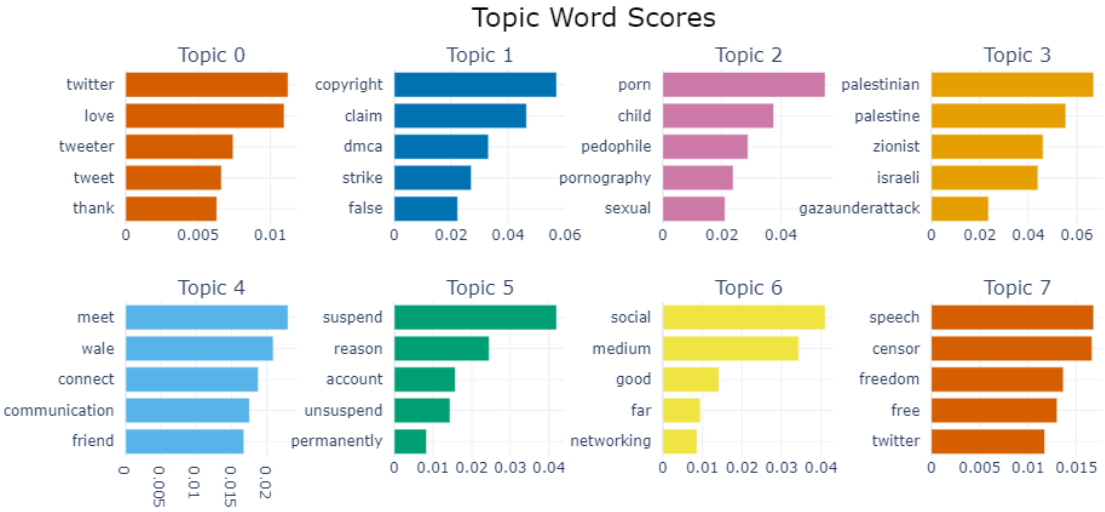

Figure 10: BERTopic topics and top words for 2021

Figure 11: BERTopic topics and top words for 2022

Figure 12: BERTopic topics and top words for 2023

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