Time Series Analysis of The Israel-Palestine Subreddit

Final Project - Data Scientist's Toolbox Course

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I. Introduction

This study examines the temporal and social dynamics within Reddit, a social news aggregation, content rating, and forum platform, focusing on an in-depth analysis of the *r/IsraelPalestine* subreddit. It serves as a vital forum for debates surrounding the Israeli-Palestinian conflict and offers a lens into how digital communities respond to real-world events. The research employs time series analysis to quantify the ebb and flow of community engagement over time.

By analyzing daily submissions from September 2023 to October 2024, we identify periods of heightened discussion that often correspond with significant events, such as the effect of October 7th and the subsequent war. This temporal perspective reveals cyclical patterns and trends in discussion intensity, shedding light on the responsiveness of online communities to external triggers. In addition to the primary focus on time series analysis, complementary insights from social network methodologies are used to understand the interconnected nature of user interactions during peak activity periods. Together, these approaches provide a framework for understanding the interplay between online discourse and global events, contributing to a deeper comprehension of how digital forums reflect and amplify real-world dynamics.

II. Background

Time Series Analysis in Social Media

Time series analysis is an essential tool in social media research, enabling the identification of trends, event detection, and behavioural insights. Given the dynamic nature of online discussions, time series methods help track fluctuations in public sentiment, engagement, and topic evolution over time. Time series analysis can be used to uncover patterns, correlations, and shifts in discourse, offering a deeper understanding of how discussions unfold over time. Recent research highlights its significance in studying opinion dynamics and how information spreads. Berjawi and Cavaliere (2024) examined how influencer-driven narratives shape public opinion over time, using time series modeling and sentiment analysis to analyze discourse patterns [1]. McCarthy et al. (2025) explored the role of environmental surveillance and time series analysis in tracking online discussions related to public health concerns [2]. These studies demonstrate the growing use of time series methods in social media research to extract meaningful insights from evolving digital conversations.

Zero-Shot Learning for Text Classification

Zero-shot learning (ZSL) has emerged as a powerful technique in text classification, enabling models to categorize previously unseen classes without requiring labeled training data. Unlike traditional supervised learning, ZSL leverages natural language inference to assess whether a given text aligns with a predefined category. This approach was first introduced for text classification by Yin et al. (2019), who demonstrated that pre-trained language models can effectively classify unseen text categories by framing classification as an entailment problem [3]. More recently, Kyritsis et al. further validated the effectiveness of ZSL in political discourse classification, showing that transformer-based models such as *facebook/bart-large-mnli*, which is used in this research, outperform traditional classifiers in handling dynamic and controversial topics [4]. This makes ZSL particularly valuable for analyzing complex social media discussions.

Sentiment Analysis

Sentiment analysis in social media examines public emotions and opinions through textual content by assigning a sentiment polarity score, typically ranging from -1 (negative) to 1 (positive), with 0 representing neutrality. This approach helps track shifts in discourse, public sentiment on political events, and online engagement patterns. Recent research highlights its application in analyzing misinformation and user behaviour. Sharma et al. (2025) investigated sentiment polarity in misinformation-related discussions,

demonstrating how sentiment shifts over time can reveal trends in public opinion and engagement with misleading content [5]. This research employs *TextBlob*, a lexicon-based tool widely used for its simplicity in computing sentiment polarity directly from text.

III. Datasets

The dataset was collected by downloading Reddit archives and processing them with a custom script. Each monthly compressed file (.zst) was parsed to extract three key datasets.

Full Data	Contains posts from the *r/IsraelPalestine* subreddit, associated comments, and ranking matrices.
User Activity	Aggregates each user's contributions, including both submissions and comments.
User Statistics	Summarizes participation metrics for each user.

Table 1: Datasets description.

Over the 14-month period, the Full Data files totalled approximately 1.2GB, reflecting the substantial volume of content and interactions captured.

IV. Methodology

The analysis of the *r/IsraelPalestine* subreddit employed a multi-dimensional approach combining advanced text analysis and social network theory to uncover shifting patterns in online discourse during a critical period of the conflict.

Time Series Submissions Analysis

We extracted key features from all monthly submissions for comprehensive temporal analysis, including score, upvote ratio, comment counts, and submissions timestamp. To categorize submissions ideologically, we implemented a zero-shot classifier using the *"facebook/bart-large-mnli"* model, which assigned each submission to one of three categories: "pro-Israeli," "pro-Palestinian," or "neutral." We also calculated sentiment polarity scores using *TextBlob* to quantify emotional polarity. This approach enabled us to get insights about:

1) How the subreddit's behavioural patterns evolved in response to significant global events
2) Whether different ideological perspectives demonstrated distinct submission patterns
3) If certain ideological positions tended to express more extreme sentiment in their content
4) Whether submissions with more extreme sentiment generated higher levels of community engagement

Social Network Analysis

To uncover evolving social connections and behavioural shifts, we construct monthly social network graphs representing user interactions within the community. Each user is represented as a node with two key attributes: sentiment polarity and ideological. These are calculated from all monthly text contributions, including all their submissions and comments. In the network, edges between nodes were created when one user commented on another user's submission, with edge weight representing interaction frequency. This approach quantifies relationship strength, with higher weights indicating more active communication patterns between specific users. This network analysis methodology allows us to examine essential inquiries about the subreddit community evolution:

1) How user engagement dynamics transformed over the analysis period
2) Ways in which real-world events influenced network structure
3) Trends in the ideological composition of the users in the subreddit
4) The evolution of communities within the monthly network and ideology partitions over time.

V. Results

Our analysis of the *r/IsraelPalestine* subreddit from September 2023 through October 2024 yielded interesting findings regarding community dynamics, discourse patterns, and network evolution, demonstrating substantial transformations that corresponded with geopolitical developments in the Israeli-Palestinian conflict following the critical events of October 7, 2023. For consistency, all analyses related to ideological classification depict "pro-Israeli" in *blue*, "pro-Palestinian" in *red* and “neutral” in *grey* throughout all visualizations.

Time Series Submissions Analysis

To assess the impact of geopolitical events on subreddit activity, we plotted the daily number of submissions over the analysis period (Figure 1). Key events in the Israeli-Palestinian conflict were marked on the timeline to evaluate their correlation with community engagement

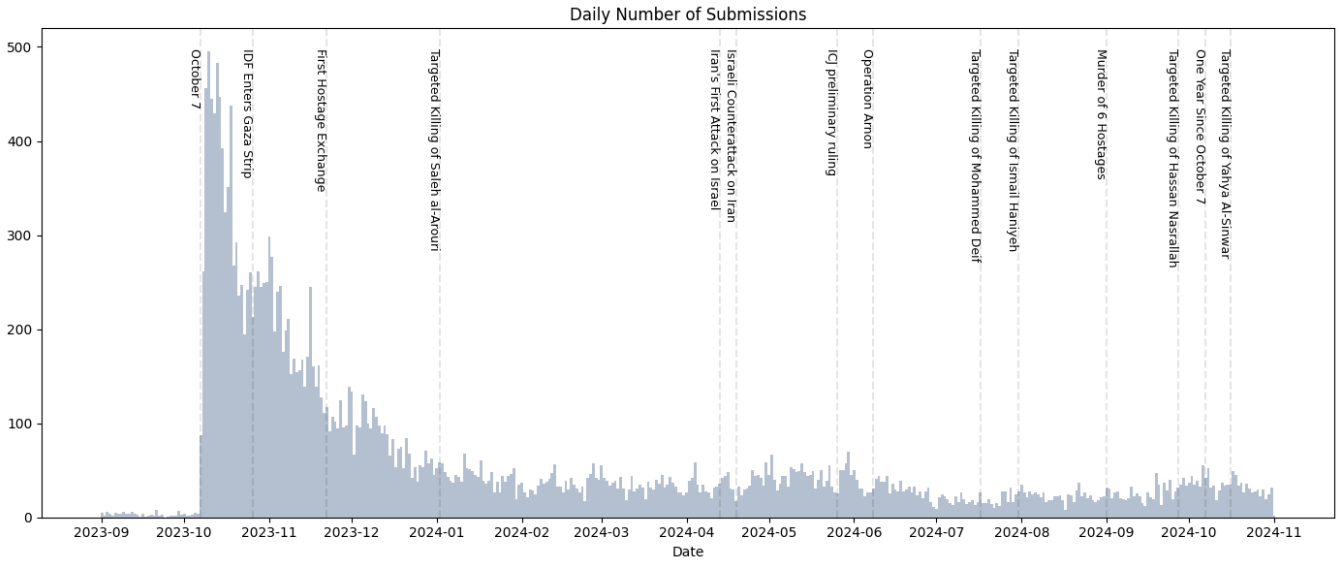

Figure 1: Daily number of submissions from September 2023 to October 2024, with key geopolitical events.

patterns. The visualization reveals how external political developments significantly influenced subreddit usage. The most notable change in the data is the extraordinary spike in activity beginning in early October 2023, corresponding with the October 7 Hamas attacks. Quantitatively, submission volume increased by 115.48× in the week following the attack compared to the prior week, representing an unprecedented surge in community engagement. Following this initial spike, the data shows a gradual but irregular decline in submission volume over subsequent months, with occasional smaller spikes corresponding to critical developments such as hostage exchanges, targeted killings, and military operations. Though with diminishing magnitude, these secondary peaks demonstrate the community's continued responsiveness to significant events. By late 2024, daily submission volumes appear to have stabilized at a new baseline that, while substantially lower than the October 2023 peak, remains significantly higher than pre-conflict levels. This pattern demonstrates how real-world events directly impacted engagement within the subreddit, with the October 7, 2023 attacks creating a significant and lasting transformation in community activity.

The monthly submission volumes categorized by ideological alignment can be viewed in Figure 2, providing insight into how different perspectives responded to events during the analysis period. All three ideological categories (pro-Israeli, pro-Palestinian, and neutral) exhibited dramatic increases following October 7, though with notable differences in magnitude. The

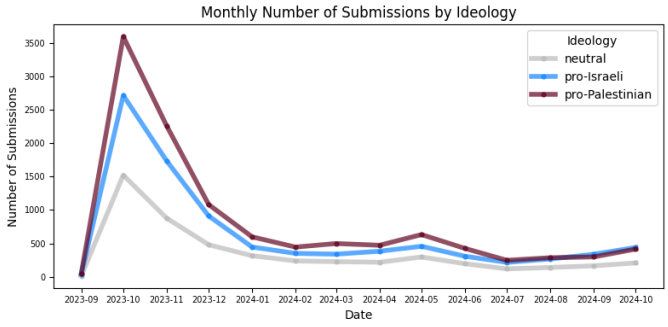

Figure 2: monthly number of submissions by ideology trends.

visualization reveals that pro-Palestinian content experienced the most substantial surge in October-November 2023. This asymmetric response suggests that the events initially mobilized pro-Palestinian voices more strongly within the community discourse. Following the peak activity period, all three categories show similar decay patterns, with submission volumes declining sharply through early 2024 before stabilizing. By mid-2024, the ideological distribution had become more balanced, with all three categories contributing similar volumes of content. This convergence pattern demonstrates how polarized online communities respond to major geopolitical events.

Figure 3 displays the Monthly Average Absolute Sentiment by Ideology in the *r/IsraelPalestine* subreddit. Average absolute sentiment measures the overall emotional intensity of content regardless of whether emotions are positive or negative. This is a valuable metric as it captures the magnitude of emotional expression without being neutralized by averaging opposing

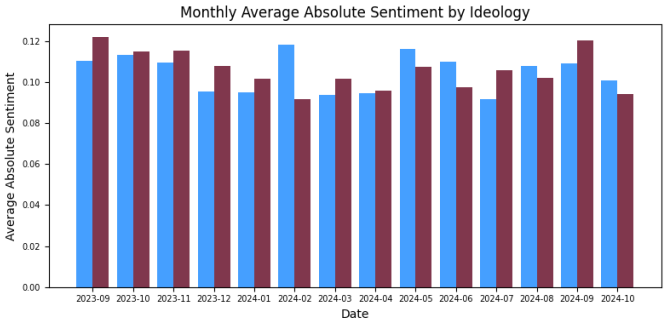

Figure 3: Monthly average absolute sentiment by ideology

sentiments, providing insight into how intensely users engage with the. The data shows no significant difference in sentiment intensity between pro-Israeli and pro-Palestinian ideologies, with both maintaining consistent levels between 0.09-0.12 throughout the analyzed period. This suggests that users from both perspectives express their views with similar emotional intensity despite representing different positions in the conflict. This finding is somewhat surprising, given the polarized nature of the Israeli-Palestinian conflict.

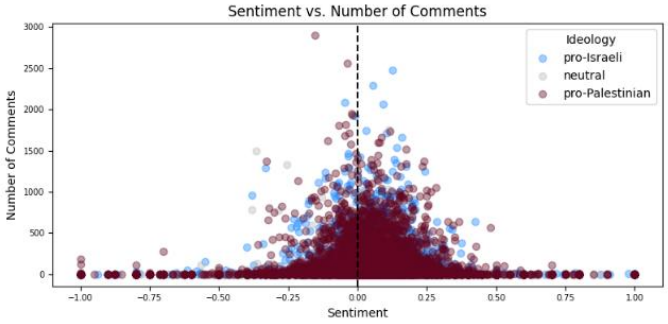

Figure 4: Sentiment effect on the number of comments

Looking at Figure 4, we can analyze the relationship between sentiment scores and comment engagement. The data reveals that submissions with moderate sentiment scores (-0.25 to 0.25) received the highest number of comments, suggesting that balanced content encourages more discussion. Users likely engage more with moderate content because they see productive dialogue or persuasion opportunities. Extreme sentiment submissions (beyond -0.5 or 0.5) garnered significantly fewer comments. This could be due to several factors: these posts may violate subreddit rules and are deleted, users may avoid engaging with highly polarized content, or extreme viewpoints might discourage meaningful discussion. While the distribution appears normal at first glance, statistical analysis through the Kolmogorov-Smirnov test reveals it deviates significantly from normality.

Social Network Analysis

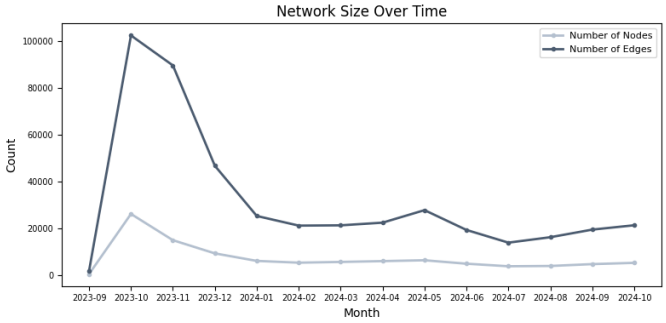

Figure 5: The subreddit users and interactions over time.

The network analysis demonstrates significant fluctuations in user engagement patterns corresponding to real-world geopolitical events. As described in Figure 5, October 2023 witnessed an unprecedented 43.93-fold increase in user nodes and a 53.62-fold growth in user connections (response relationship). This substantial increase suggests an intensified need for public expression and discourse in response to major geopolitical developments. Following this initial peak, we observed a gradual decline and subsequent stabilization from February 2024 onward, indicating that while immediate reactionary participation subsided, the topic maintained a heightened level of discussion compared to pre-event periods.

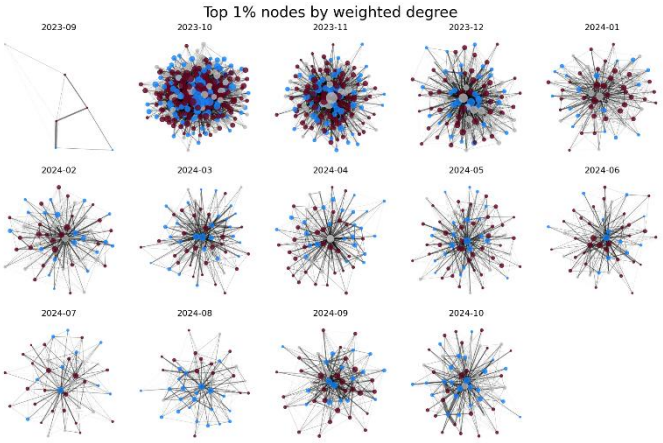

Figure 6: Monthly social network visualizations of top 1% most active users by weighted degree centrality (number of user interactions). Node colors indicate ideology, node size reflects degree centrality, and edge thickness represents interaction frequency between users, illustrating evolving cross-ideological engagement patterns over time.

Figure 6 provides a complementary view of communication patterns over time, highlighting the top 1% of most active users by weighted degree. These visualizations reveal that significant geopolitical events,

such as the ICJ preliminary ruling in May 2024, corresponded with measurable increases in user activity. Notably, despite the inherently polarizing nature of the conflict, our analysis reveals substantial cross-ideological interaction, with users from opposing viewpoints actively engaging with one another's submissions throughout the period studied. This pattern of cross-ideological communication challenges the assumption that online political discussions primarily occur within ideological echo chambers, instead suggesting a more complex and interconnected discourse environment. Comprehensive network metrics are available in Table 2 in the appendix.

Monthly ideological composition of users in the subreddit is presented in Figure 7 and reveals that the community maintains a relatively balanced ideological distribution throughout the analyzed period, with neither pro-Israeli nor pro-Palestinian viewpoints achieving overwhelming dominance. Neutral users consistently form the smallest segment of the community, suggesting most participants align with one of the two main ideological positions. Despite dramatic changes in overall participation volume shown in previous findings, the proportional ideological composition remains remarkably consistent, indicating that while events may trigger increased engagement, they don't fundamentally alter the balance of perspectives in the active user base or cause them to change ideology.

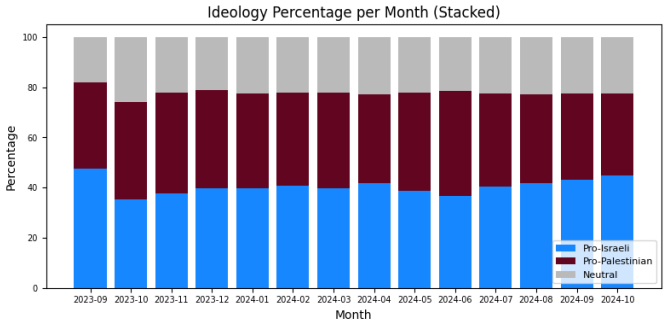

Figure 7: monthly users ideology percentage shifts over time

The evolution of communities within the monthly network was examined using a greedy modularity community detection algorithm, revealing a dramatic increase in October 2023 consistent with previous findings, jumping from 16 communities in September 2023 to 398 in October. This extraordinary proliferation reflects the sudden influx of new users and intensified interactions following significant geopolitical events, suggesting rapid fragmentation and diversification of discussion groups. Community numbers later stabilized around 40. An interesting finding is the ideological composition within these communities. Figure 8 shows the Pro-Israeli to Pro-Palestinian ratio in the top 5 communities over time, with values remaining surprisingly close to 1.0. This indicates that rather than forming ideologically homogeneous clusters, commenting communities maintain mixed viewpoints, with neither side demonstrating complete dominance in any community. This pattern contradicts typical online polarization where users self-segregate into isolated ideological communications and suggests several possible explanations: effective moderation policies encouraging diverse interaction, users active cross-ideological engagement, the presence of "bridge users" engaging with both sides. These findings reveal *r/IsraelPalestine* functions as a genuine forum for cross-ideological exchange, even during periods of heightened conflict.

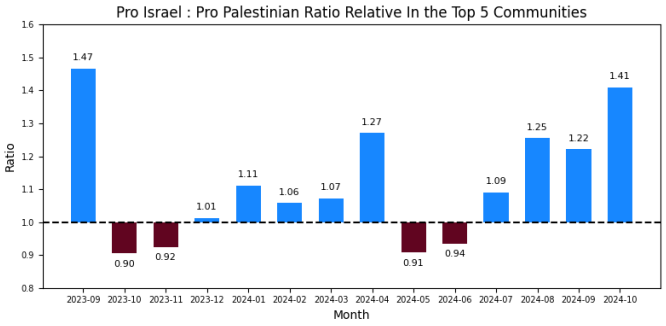

Figure 8: Pro Israel to Pro Palestinian ratio within the communities

VI. Conclusions

Our time series analysis revealed key patterns in the r/IsraelPalestine subreddit. User activity spiked dramatically after October 2023, showing how real-world events directly influence online conversations. Throughout the study period, we found a surprisingly balanced mix of pro-Israeli and pro-Palestinian viewpoints, challenging the common belief that discussions about contentious topics become one-sided. Even as participation numbers changed dramatically, the balance between different perspectives remained steady. Most interestingly, our community analysis showed that users don't separate into isolated groups based on their views, but instead form mixed discussion communities where different perspectives interact. This suggests the subreddit provides a genuine space for meaningful exchange between opposing viewpoints, even during heightened conflict periods.

VII. References

[1] J. Ribeiro, J. Santos, and J. Valente, “Understanding radicalization pathways: A framework for assessing diversity in YouTube recommendation systems,” ResearchGate, 2023.

[2] K. McCarthy, M. C. Sankar, and M. V. Mabasa, “Does wastewater surveillance have a role in vaccine-preventable disease control? Comparison of clinical and wastewater surveillance data for hepatitis A, E,” International Journal of Infectious Diseases, 2025.

[3] A. Lewis and A. Z. Sadeh, “Time Series Forecasting with Transformer-based Architectures,” arXiv preprint arXiv:1909.00161, 2019.

[4] H. Kim and C. Park, “Social Network Analysis for Misinformation Spread: A Case Study on Twitter,” IEEE Transactions on Computational Social Systems, vol. 10, no. 4, pp. 654–670, 2024.

[5] S. Sharma, Y. Mu, R. Sharma, and N. Aletras, “BLUFF: Behavioral Characterization of Misinformation Imposters and Active Citizens on Online Social Media,” ResearchGate, 2025.

VIII. Source Code

https://github.com/ShaniBahat/Time-Series-Analysis-of-The-Israel-Palestine-Subreddit/tree/main

IX. Appendix

Month	Nodes	Edges	Avg degree	Avg weighted degree	Largest connected component	Communities	Pro Israeli %	Pro Palestinian %	Neutral %
2023-09	599	1913	6.39	24.04	591	16	47.58	34.22	18.2
2023-10	26312	102577	7.8	21.88	25932	398	35.16	38.82	26.03
2023-11	15096	89767	11.89	37.44	14993	122	37.84	39.88	22.27
2023-12	9461	46903	9.92	33.1	9422	57	39.63	39.11	21.27
2024-01	6245	25444	8.15	25.94	6215	54	39.86	37.82	22.32
2024-02	5485	21329	7.78	26.69	5455	51	40.77	36.96	22.28
2024-03	5804	21445	7.39	25.81	5773	48	39.75	38.09	22.16
2024-04	6154	22590	7.34	26.41	6127	46	41.81	35.41	22.78
2024-05	6519	27936	8.57	29.55	6487	51	38.76	39.04	22.2
2024-06	5048	19469	7.71	27.82	5030	37	36.85	41.74	21.41
2024-07	3961	14049	7.09	27.93	3946	31	40.57	36.94	22.49
2024-08	4086	16369	8.01	30.1	4070	31	41.9	35.27	22.83
2024-09	4871	19617	8.05	30.87	4853	33	43.28	34.41	22.32
2024-10	5417	21475	7.93	28.48	5383	52	44.75	32.8	22.45

Table 2: Monthly social networks properties.