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SocialMediaAvengers Project 3 Report

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Abstract

Project 3 extends Project 2 by moving from descriptive social media measurements to an explanatory analysis of engagement dynamics across Reddit and 4chan. The original proposal aimed to examine how post types—such as questions, opinions, news, and memes—affect engagement using metrics including reply count and thread activity, supported by an interactive exploration tool.

In this work, we implemented an interactive analytics dashboard that partially fulfills these objectives. Using Reddit and 4chan datasets enriched with Perspective API toxicity scores, the dashboard enables exploration of temporal posting trends, engagement by post type, platform-level toxicity differences, and event-driven discussion patterns. Although not all proposed engagement measures (e.g., detailed thread structure and reply velocity) were fully implemented, our analysis of replies, thread counts, and post-type comparisons provides meaningful insight into participation behavior.

Results show clear platform differences: 4chan exhibits higher average toxicity and sharper event-driven spikes, while Reddit demonstrates more stable and moderated discussions. Post-type analysis indicates that meme posts generate high participation, news posts encourage deeper discussions, and question posts promote focused interaction. An event-based case study of the Cloudflare outage on November 18 illustrates short-lived but intense bursts of engagement. Additionally, we integrated a LangChain-based AI agent that supports natural-language querying of the data, enabling exploratory analysis beyond static visualizations.

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1 Introduction

1.1 Motivation and Background

Online platforms such as Reddit and 4chan play an important role in shaping public discourse on technology, geopolitics, and emerging AI systems. Due to differences in moderation policies and community norms, these platforms exhibit distinct engagement behaviors

and toxicity patterns, making them suitable for comparative analysis. In Project 2, we focused on continuous data collection and basic characterization, including post volumes, board and subreddit activity, and toxicity scoring. While this provided an overview of the dataset, it did not support interactive exploration or event-driven analysis. Project 3, as outlined in the proposal, shifts from static characterization to answering concrete research questions through an interactive system, enabling deeper engagement analysis and temporal investigation.

1.2 Research Question and Objectives

RQ1: *How do engagement patterns and toxicity levels differ between Reddit and 4chan across technology-, geopolitics-, and AI-related discussions, particularly during real-world events?*

The Project 3 proposal aimed to answer at least one research question from Project 2 using an interactive tool that supports multiple analyses, including engagement trends, toxicity comparison, and event-based activity. To achieve this, we implemented a web-based dashboard providing separate Reddit, 4chan, and cross-platform comparison views.

Overall, this project focuses on short-term engagement dynamics, platform-level toxicity differences, and interactive analysis of Reddit subreddits and 4chan boards related to technology, geopolitics, and AI, aligning with the proposal objectives while expanding its analytical scope.

1.3 Data Collection and Preprocessing

The data used in this project was collected through the SocialMediaAvengers continuous crawling pipeline developed in Project 1 and extended in Project 2. The dataset spans a one-month collection window from October 24 to November 25, 2025, and includes content from both Reddit and 4chan communities selected for their relevance to technology, geopolitics, and AI-related discussions. Specifically, Reddit data was collected from r/technology, r/AI, r/geopolitics, and r/AutoGPT, while 4chan data was collected from the /pol/, /int/, and /g/ boards.

For analyzes related to AI discussions, a focused subset of approximately 74,124 AI-related posts was constructed using keyword matching for AI models and tools (e.g. AutoGPT, GPT-family models), consisting of 24,606 posts from 4chan and 49,518 submissions and comments from Reddit.

To support toxicity analysis, a large but restricted slice of the corpus was scored using the Google Perspective API due to rate and credit limitations. Toxicity scores were calculated for posts collected between November 11 and November 25, 2025, covering 250,625 posts from 4chan and 38,559 posts from Reddit, for a total of 289,184 entries tagged with toxicity. These scores form the basis for all toxicity comparisons at the platform and community-level on the dashboard.

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Preprocessing steps included basic cleaning and validation, such as removing records with missing text or timestamps, standardizing time formats, and aligning platform-specific metadata into a unified schema. content-based filtering was not applied beyond these validity checks, ensuring that observed engagement and toxicity patterns reflect natural platform behavior rather than aggressive preprocessing. The resulting data set provides a structured foundation for the engagement analysis, dashboard visualizations, and event-based case study presented in this report.

2 System Architecture and Interactive Tool

2.1 Overview of the Analytics Dashboard

We developed a web-based analytics dashboard to support interactive exploration of engagement and toxicity patterns across Reddit and 4chan. The system provides three integrated views: a Reddit dashboard, a 4chan dashboard, and a cross-platform comparison view. Together, these views enable users to analyze temporal activity trends, engagement by post type, toxicity levels, and event-driven discussions through interactive visualizations.

2.2 Backend Architecture

The backend is implemented using **FastAPI** and serves as the analytical core of the system. Two separate PostgreSQL databases are maintained for Reddit and 4chan to accommodate structural differences between platforms. Each database stores post metadata, engagement indicators, and Perspective API toxicity scores.

A set of RESTful APIs powers the dashboard, supporting analyses such as daily activity trends, engagement by post type, platform-level toxicity comparison, and event-centered timelines. All endpoints accept user-defined parameters, including date ranges, boards or subreddits, and post categories, ensuring that results are computed dynamically. In addition, a LangChain-based SQL agent enables natural-language querying of the databases, extending exploratory analysis beyond predefined visualizations.

2.3 Frontend Dashboards and Interactivity

The frontend is built using **Next.js**, **React**, and **TypeScript**, with charts rendered using **ApexCharts**. The Reddit dashboard presents subreddit-level activity and engagement metrics, while the 4chan dashboard focuses on board-level trends and geographic distributions. The comparison dashboard enables side-by-side analysis of engagement and toxicity across platforms.

User-controlled filters allow selection of date ranges, communities, post types (news, opinions, questions, and memes), and platforms. Filter changes directly modify backend queries, causing visualizations to update in real time. This design ensures that the system functions as an interactive analytical tool rather than a static reporting interface, fulfilling the Project 3 requirement for interactive exploration of analyses derived from Project 2.

3 Engagement and Toxicity Analysis

This section presents the key results addressing RQ1 using dynamically computed analyses from the interactive dashboard described in Section 3.

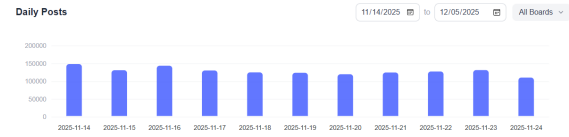


Figure 1: Daily posting activity by board on 4chan. The plot shows sharp activity spikes and short-lived engagement bursts, particularly on politically oriented boards such as /pol/.

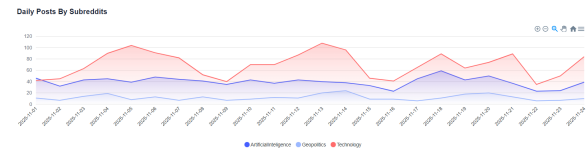


Figure 2: Daily posting activity by subreddit on Reddit. Compared to 4chan, activity patterns are more stable over time, with fewer abrupt spikes across major subreddits.

3.1 Temporal Engagement Trends

Temporal engagement trends are analyzed using daily post count time series for both platforms. Reddit activity is aggregated by subreddit, allowing comparison across communities within a common time window, while 4chan activity is aggregated by board.

Figures 1 and 2 reveal a clear contrast in engagement dynamics. Reddit shows relatively stable daily posting behavior, with gradual fluctuations and few extreme spikes across major subreddits such as technology and geopolitics. In contrast, 4chan boards exhibit sharp, short-lived spikes in activity, with sudden increases and rapid declines concentrated within narrow time intervals. These spikes indicate highly reactive engagement patterns, suggesting that Reddit discussions are more persistent over time, whereas 4chan engagement is driven by brief, event-focused bursts of attention.

3.2 Post-Type Engagement

Engagement by post type is analyzed using the /engagement/by-type endpoints for both platforms and visualized in the platform comparison dashboard. Post categories include news, opinions, questions, and memes, as defined during data preprocessing.

Figure 3 shows that content format strongly influences participation. Meme-related posts generate high overall engagement on both platforms due to rapid interaction and frequent replies. News posts consistently lead to deeper discussion threads, particularly on Reddit, where comment activity remains sustained over time. Question-based posts exhibit more focused interaction, with fewer but more targeted replies, while opinion posts show moderate engagement across platforms.

These results indicate that engagement patterns are shaped not only by platform norms but also by the structural characteristics of the content itself.

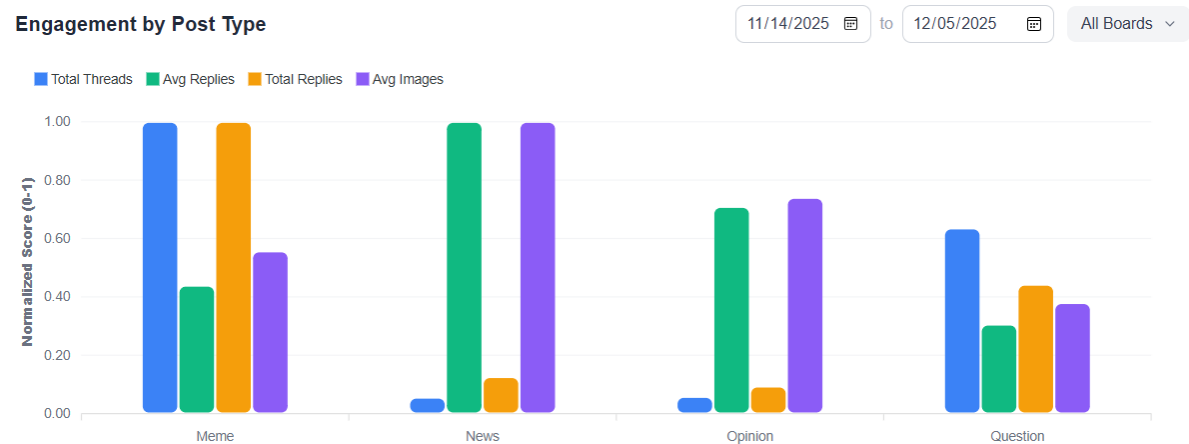


Figure 3: Engagement by post type across Reddit and 4chan. Meme and news posts generate higher participation, while question posts lead to more focused interaction.

3.3 Platform-Level Toxicity Comparison

Platform-level toxicity is computed as the average Perspective API toxicity score per board or subreddit and visualized in the comparison dashboard. Figure 4 presents the distribution of average toxicity values across major Reddit subreddits and 4chan boards.

The results reveal a pronounced contrast between platforms. Reddit communities exhibit consistently lower average toxicity scores, reflecting the influence of moderation and community guidelines. In contrast, 4chan boards—particularly those centered on political discussion—display substantially higher toxicity levels and greater variability over time. This pattern aligns with the temporal engagement trends, where periods of elevated activity on 4chan frequently coincide with increased toxicity.

Overall, these analyses demonstrate that Reddit supports more stable and moderated engagement, while 4chan exhibits higher volatility and toxicity, especially during periods of intensified discussion. Together, these findings directly address RQ1 by highlighting how engagement dynamics and toxicity differ across platforms and content types.



Figure 4: Average Perspective API toxicity scores across major Reddit subreddits and 4chan boards, illustrating substantially higher toxicity and variability on 4chan.

4 Cloudflare Outage Discussion Trends (2025-11-18)

Figure 5 shows the daily volume of posts discussing the Cloudflare outage over a seven-day window centered on November 18, 2025. Discussion activity remains low and stable prior to the event, followed by a sharp and pronounced spike on the outage day. This

spike represents a concentrated burst of attention as users reacted immediately to service disruptions. In the days following the outage, discussion volume declines rapidly, indicating that engagement was highly time-sensitive and short-lived on both 4chan and Reddit.

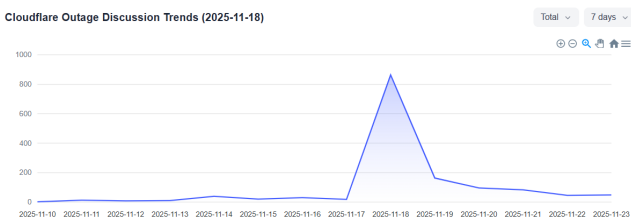


Figure 5: Event-centered discussion timeline for the Cloudflare outage on November 18, 2025. The figure shows a sharp, short-lived spike in activity, followed by a rapid decline in discussion volume.

5 AI Agent for Exploratory Analysis

5.1 Motivation

While the interactive dashboard enables structured exploration through predefined visualizations and filters, it is limited to analyses explicitly implemented in the interface. To support more flexible and exploratory analysis, we integrated an AI-based agent that allows users to query the underlying data using natural language. The motivation for this addition is to enable ad-hoc analysis without requiring users to manually construct SQL queries or navigate multiple dashboard views.

5.2 LangChain-Based Natural Language Querying

The AI agent is implemented using **LangChain** and is connected directly to the PostgreSQL databases storing Reddit and 4chan

data. User queries expressed in natural language are translated into executable SQL queries, which are then run against the appropriate platform-specific database. The results are returned in a structured format and can be used to derive insights beyond the scope of fixed dashboard components.

This design allows the agent to operate over the same data and metrics used by the dashboard, ensuring consistency between agent responses and visualized analyses.

5.3 Supported Analytical Queries

The agent supports a range of exploratory questions related to engagement and toxicity. Example queries include:

- Identifying boards or subreddits with the highest activity during a specified time window.
- Comparing average toxicity levels across platforms or communities.
- Retrieving engagement statistics for specific post types within a given date range.
- Examining discussion volume related to particular events or keywords.

These queries allow users to investigate patterns that may not be immediately visible through standard charts, enabling deeper exploration of the data.

5.4 Extending Dashboard-Based Exploration

By combining dashboard-driven analysis with natural language querying, the AI agent extends the system's exploratory capabilities. Users can move fluidly between visual summaries and targeted queries, using the agent to validate observations, drill down into specific cases, or generate new hypotheses. This hybrid approach enhances the analytical flexibility of the system and demonstrates how AI-assisted tools can complement traditional dashboard-based social media analysis.

6 Discussion

This section synthesizes the findings presented in Sections 4–6 and interprets them in relation to the original Project 3 proposal.

6.1 Summary of Key Findings

Our analysis reveals clear and consistent differences in engagement dynamics and toxicity between Reddit and 4chan. Across temporal activity trends, Reddit exhibits relatively stable daily posting behavior, while 4chan shows abrupt, short-lived spikes in activity. Post-type analysis indicates that meme and news posts generate the highest engagement across both platforms, though Reddit discussions tend to persist longer, particularly for news-related content. Toxicity analysis further highlights that average Perspective API scores are consistently lower on Reddit, whereas 4chan boards—especially politically oriented ones—show higher toxicity levels and greater variability.

The event-based Cloudflare outage case study reinforces these observations. Discussion volume surged sharply on the outage day, reaching its peak within a single day, and then declined rapidly. The spike was more pronounced and short-lived on 4chan, while

Reddit maintained elevated discussion levels for a longer period due to follow-up explanations and commentary.

6.2 Interpretation of Platform Differences

These findings suggest that platform design and moderation practices strongly shape engagement behavior. Reddit's moderation structure and threaded discussion format encourage sustained conversations and lower toxicity, resulting in smoother activity curves and longer-lived engagement. In contrast, 4chan's minimal moderation and ephemeral posting style promote rapid reactions, higher volatility, and elevated toxicity. The sharp spikes observed in both temporal trends and event-driven analysis indicate that 4chan engagement is highly reactive and closely tied to breaking events, whereas Reddit functions more as a space for extended discussion and information exchange.

6.3 Alignment with Proposal Expectations

The Project 3 proposal anticipated that engagement patterns and toxicity levels would differ across platforms and post types, and that real-world events would trigger observable discussion surges. These expectations are largely confirmed by the results. However, while the proposal originally emphasized fine-grained engagement measures such as reply velocity and thread depth, the implemented analysis focused primarily on reply counts, post volumes, and aggregated toxicity metrics. Despite this limitation, the observed trends still provide meaningful insight into how content format, platform norms, and external events influence participation.

6.4 Limitations of Engagement Measures

The current engagement measures capture overall participation levels but do not fully represent conversational structure. Metrics such as reply count and daily post volume do not distinguish between shallow and deeply nested discussions, nor do they capture the temporal ordering of replies within threads. As a result, some aspects of engagement intensity—such as how quickly users respond to posts or how discussions branch over time—are not directly measured in the current system.

7 Limitations and Future Work

7.1 Analytical and Data Limitations

Several limitations remain in the present implementation. First, the absence of detailed thread graphs prevents analysis of reply depth, conversational branching, and user interaction networks. Second, engagement is measured at an aggregated level, which may obscure fine-grained temporal patterns such as reply velocity immediately following post creation. Third, the analysis is limited to a subset of boards and subreddits and a finite time window, which constrains the generalizability of the findings.

Scalability is also a consideration, as the current system operates on pre-collected datasets rather than continuous, real-time streams. Expanding coverage to longer time horizons or additional platforms would require further optimization of data ingestion and query performance.

7.2 Planned Extensions

With additional time and data, several extensions are planned. These include incorporating reply timing to compute response velocity, constructing full thread graphs to measure discussion depth and branching, and extending event-based analysis to multiple incidents for comparative evaluation. Additional toxicity dimensions, such as sentiment polarity and topic-specific toxicity,

8 Conclusion

This project examined engagement dynamics and toxicity patterns across Reddit and 4chan using an interactive analytics framework. By combining dashboard-based visual analysis, event-centered timelines, and a LangChain-powered AI agent, we addressed RQ1 by analyzing how participation patterns, content structure, and real-world events influence discussion behavior on both platforms.

The results reveal clear platform-level differences. Reddit exhibits more stable engagement over time, lower average toxicity, and longer-lived discussions, particularly for news-oriented content. In contrast, 4chan displays higher volatility, sharper activity spikes, and elevated toxicity, with engagement often concentrated in short, event-driven bursts. The Cloudflare outage case study further highlights these differences, demonstrating how external incidents trigger rapid but uneven engagement responses across platforms and emphasizing the importance of event-centered analysis for capturing transient dynamics.

The integration of an AI agent extends the system beyond pre-defined visualizations by enabling flexible, natural-language exploration of engagement and toxicity metrics. Together, the dashboard, event-based analysis, and AI-assisted querying illustrate how interactive and AI-driven tools can provide deeper insight into cross-platform social media behavior than static analysis alone. Overall, this work presents a practical framework for analyzing engagement dynamics across online platforms and underscores the value of combining interactive visualization with AI-supported exploratory analysis in social media research.

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