

Reddit Submissions Topic Modelling and Sentiment Analysis on Collapse of Terra (LUNA) Event

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Abstract—The collapse of the Terra (LUNA) blockchain protocol on May 9th, 2022, marked a significant event in the cryptocurrency space, leaving a profound impact on its holders. In this study, we explore the progression of events surrounding the collapse and its effects on the network structure and influential users within the cryptocurrency community. As the discussions surrounding the event evolved, we observed changes in the network structure, leading to the emergence of influential users who actively shaped the topics of discourse.

Our investigation into the sentiments expressed by these top users yielded intriguing results. Contrary to expectations, these users were not known for displaying extreme sentiment polarities; instead, they expressed their thoughts, knowledge, and information in a lucid and detailed manner. Moreover, their language usage demonstrated a propensity for well-constructed and comprehensive responses, underscoring their expertise and active engagement with the discussed topics.

The collapse of the Terra (LUNA) blockchain protocol served as a significant event that allowed us to gain insights into the dynamics of network structures and user sentiments within the cryptocurrency community. Our findings shed light on the behavior of influential users during moments of crisis and highlight the importance of thoughtful and informative contributions within the crypto space.

Index Terms—cryptocurrency, collapse, network, social, Reddit

I. INTRODUCTION

The collapse of Terra (LUNA) blockchain protocol which consists of TerraUSD and LUNA cryptocurrencies on May 9th 2022 was considered to be one of the biggest events in the crypto space, largely due to the magnitude of its collapse as well as the impact it brought to its holders. Luna was one of the top ten cryptocurrencies on the market prior to the crash, but after the crash, almost \$45 billion of market capitalisation was wiped out. The price of LUNA, the cryptocurrency which serves as the asset which backs the Terra blockchain protocol, fell from its all-time high of \$119.51 all the way to "virtually zero".

A. Motivation

Social media enables sharing of various types of information and knowledge. Specifically, it plays a role of a representative of what people are thinking or feeling at any given moment. Therefore, studying how events affect the way people communicate and interact with each other on social media is a particularly interesting research field.

As one of the most active social media in terms of discussions and updates about the crypto space, Reddit provide a

unique opportunity to carry out clean topic-specific analyses of users' attitudes in social posting due to its subreddit feature, where users can submit content and comments about a very specific topic, and moderators actively remove contents not following each subreddit's rules.

In this project, we are interested in studying and analyzing if and how the collapse of Terra (LUNA) blockchain protocol impacted Reddit users in their social posting habits and attitudes. We consider two aspects: topic modelling of posts and sentiments expressed by the users within their posts.

B. Problem Statements

Identify Top Users As Reddit users respond to the collapse of Terra (LUNA) in the various subreddits, influential and top users will rise and be more prominent in the discussions within the subreddits. By analyzing the attributes around these top users, we can better understand how the event progressed.

Analyze Sentiments Analysis on sentiments expressed through these contents and comments regarding the collapse can also paint a clearer picture about the collapse.

Analyze Topics Additionally, different discussion topics will form within the subreddits as well as around the top users, depending on how different users and communities' stances are on the protocol. By analyzing these different discussion topics, the type of users and the topics discussed in these various communities can be understood better.

Establish How Topics and Sentiments Correlates with LUNA's Price Utilizing analysis results on the first three problem statements above and linking the findings to how the price of LUNA moved will then help establish how social media users respond to events, particularly drastic movements in prices.

C. Paper Structure

The structure of this paper is organized as follows. The background information and concepts necessary to understand the context will be introduced in Section II. Section III will explain about previous related works on this particular topic; while in section IV, the data collection process will be discussed. The timeline of how the event took place is described in section V, while the methods used to analyze the dataset is discussed in Section VI. The results and analysis of the study make up Section VII, and finally, the study is concluded with Section VIII.

II. BACKGROUND

A. Reddit and Cryptocurrency-related Subreddits

In this study, we collect data from Reddit¹. Reddit is a social media where users can create discussion groups called *subreddits* and interact with each other pseudonymously through screen names in moderation [1]. Usually, these subreddits represents a specific online community along with the posts or submissions associated with it. A subreddit is denoted by *r/*, followed by the subreddit's name (e.g., *r/jokes*).

There are several features that a user can do in Reddit, for example, a user can post submissions, comments on existing submissions, and subscribe to the subreddits.

Reddit has played a significant role in shaping and contributing to the crypto scene [2]. The platform has become a hub for cryptocurrency enthusiasts, investors, developers, and traders to connect, share knowledge, and discuss various aspects of the industry.

Reddit's decentralized structure allows for diverse perspectives and a wealth of information to be shared freely. Additionally, the platform has been instrumental in facilitating the discovery of promising projects and identifying potential risks through user-driven discussions and due diligence.

Several subreddits related to cryptocurrency topics include:

- *r/CryptoCurrency*: one of the largest subreddits discussing all aspects of cryptocurrencies.
- *r/Bitcoin*: A subreddit focused on Bitcoin-related discussions.
- *r/Ethereum*: This subreddit is dedicated to Ethereum, the second-largest cryptocurrency by market capitalization.
- *r/Altcoin*: This subreddit discusses cryptocurrencies or altcoins outside of Bitcoin and Ethereum.
- *r/CryptoMarkets*: This subreddit focuses on cryptocurrency trading, investment strategies, technical analysis, and market trends.
- *r/Blockchain*: This subreddit covers blockchain technology beyond cryptocurrencies, such as smart contracts and decentralized finance (DeFi).

B. Cryptocurrency, Blockchain, and Terra (LUNA)

The world of cryptocurrencies has undergone significant advancements in recent years, with a notable increase in the adoption of blockchain-based assets. It all began with Bitcoin, which was introduced in 2008 by an activist known as Satoshi Nakamoto. Serving as a precursor to other cryptocurrencies, Bitcoin paved the way for similar ventures and continues to maintain its leading position in terms of capitalization.

The second-largest project in the cryptocurrency realm today is Ethereum, which has been under development since 2013 by Vitalik Buterin. While Bitcoin only allowed for anonymous money transfers outside the control of central banks, Ethereum took a step further by introducing smart contracts. These contracts are pieces of code that execute in a deterministic manner, leading to the creation of a thriving community. Developers eagerly embraced the opportunity to

create their own smart contracts, enabling the development of complex applications like decentralized exchanges (DEX), where users could easily and anonymously trade tokens within the same blockchain. This revolutionary mechanism facilitated anonymous and decentralized transactions through Liquidity Pools, where users invested their capital and received a percentage of transaction remuneration.

Terra (LUNA), another cryptocurrency project, also provides users with the ability to write their own smart contracts. Unlike Bitcoin, which relies on Proof of Work for transaction consensus, Luna uses Proof of Stake, a more organic mechanism. Terra also introduced a Stablecoin, which is a virtual currency pegged to a fiat currency and stored on a blockchain. This means that a virtual dollar, referred to as TerraUSD (UST), exists on the Terra blockchain. Several ventures offer their stablecoins, with Tether (USDT), Binance (BUSD), and Centre (USD Coin) having the highest capitalization. Users can deposit a specific amount of USD and receive an equivalent value in the respective stablecoin from these institutions. To ensure consumer funds' security, these companies regularly publish audits disclosing the type of collateral they hold.

In contrast, Terra (LUNA) took a different approach by implementing an algorithmic stablecoin. Just before LUNA experienced a crash, its corresponding stablecoin, TerraUSD (UST), ranked third in terms of capitalization among all stablecoins. Luna provided low-cost transactions that finalized within minutes. The operating mechanism of LUNA is as follows: when there is an increased demand for UST, LUNA tokens are burned to match the supply. This process also operates in reverse. From a user's perspective, this mechanism allows for arbitrage opportunities. For example, if UST is valued at \$1.01, a user can sell \$1 worth of LUNA and exchange it for 1 UST, earning \$0.01 per LUNA. Users exploit this opportunity to realize profits, increasing the supply of UST and lowering its price when UST exceeds \$1. Conversely, if UST falls below \$1, such as \$0.99, users can purchase \$1 worth of LUNA for 1 UST, reducing the supply of UST and driving up its price. However, this self-regulating mechanism did not rely solely on users. The Luna Foundation Guard (LFG) institution played a role in maintaining the UST price at \$1, backed by collateral capital. At its peak, this collateral amounted to over 45,000 Bitcoins, valued at \$1.3 billion. Yet, in retrospect, it is fair to say that even such a substantial reserve was not sufficient to protect UST from attacks.

C. The Crash of Terra (LUNA)

Prior to its crash, UST held the position of the fourth-largest stablecoin, trailing behind Tether (USDT), USD Coin (USDC), and Binance USD (BUSD), with a market capitalization of \$18 billion. According to Terra's whitepaper, the underlying protocol of UST relied on a two-coin system that was not fully backed by traditional collateral such as fiat currency or gold [3]. Terra, as an algorithmic stablecoin, had its value pegged to various fiat currencies, resulting in fiat-based stablecoins like TerraUSD, TerraEUR, and TerraKRW. Conversely, Luna token (LUNA) acted as a counterbalance to reduce the volatility

¹<https://www.reddit.com/>

of UST. The LUNA-UST protocol operated on two main concepts: first, it stabilized UST prices by ensuring equilibrium in supply and demand through arbitrage, utilizing the LUNA pool as a counterweight. Second, the Terra protocol's algorithmic market module enabled arbitrageurs to trade \$1 worth of LUNA for 1 UST, regardless of the prices of LUNA and UST [4].

The Anchor protocol, a lending and borrowing protocol within the Terra ecosystem, gained significant popularity as a high-interest savings account for UST holders. Before the collapse of the Terra project, Anchor attracted 75% of the circulating supply of UST by offering a 20% annual percentage yield (APY) to depositors. However, this strong reliance on the Anchor protocol left the Terra project highly exposed to extreme market conditions.

In April 2022, SwissBorg, a Swiss-based crypto exchange, highlighted the risk that UST holders might fear the stability of the UST peg and decide to redeem their UST positions. This redemption process involves burning UST and selling minted LUNA on the market, potentially leading to a further decline in LUNA's price. This downward spiral, similar to how a "bank run" might have happened, ultimately occurred to LUNA-UST.

Two main events served as triggers for the Terra collapse. First, private market actors shorted Bitcoin, creating panic. Second, a liquidity pool attack on Curve-3pool caused the initial de-pegging of UST below \$0.99. Despite efforts by the Luna Foundation Guard (LFG) to restore stability, the UST peg was lost for the second and final time. The attackers may have forced LFG to sell BTC, decreasing its price and increasing the attackers' profits.

On May 11, 2022, the Terra Team announced a community proposal to burn UST and mint LUNA in an attempt to save the project. However, by that point, the community's trust in the project had been lost, leading to the complete collapse of both LUNA and UST tokens. The tokens' values plummeted from \$87 and \$1, respectively, on May 5, 2022, to less than \$0.00005 and \$0.2 on May 13, 2022, as shown on **Fig. 1**. The estimated profits for the potential attackers exceeded 800 million. It is important to note that claims of a coordinated attack using BTC to destabilize the UST peg are based on contradictory social media rumors, and the attack on Terra and the potential BTC short selling positions may have been unrelated operations carried out by different market actors.

III. RELATED WORK

A. Cryptocurrency-related Research in Reddit

The occurrence of information cascades on online social networks (OSNs), or social media, refers to the situation where an idea spreads on the social media due to the influence of neighboring connections, and this phenomenon has been extensively researched [5]–[7]. Specifically on Reddit, [8] found that majority of large, viral conversations are primarily initiated by a small subset of users who engage in reciprocal communication with others. Results exhibited by [2] show that the volume and length of discussion differ across various cryptocurrencies on Reddit.

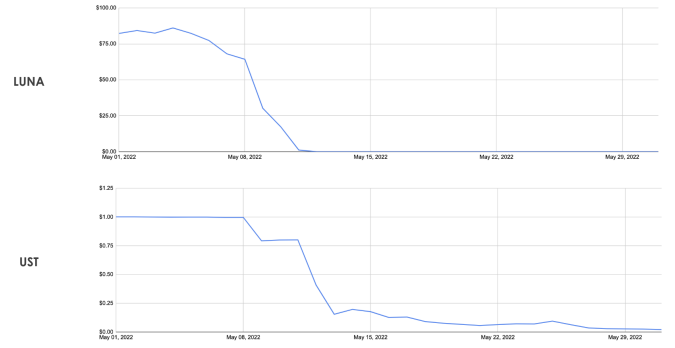


Fig. 1. Price of LUNA and UST throughout May 2022

B. Terra (LUNA) collapse related Research

Events and causes of the Terra (LUNA) crash has been studied extensively [9]–[12], identifying triggers, analyzing transaction data leading up to the crash, and summarizing the impact of the crash on cryptocurrency market and market sentiment.

C. Work on Topic-based Social Network Analysis

Identifying influential or central actors, finding hubs and authorities using link analysis algorithms, detecting communities within the network, visualizing interactions between actors, and studying information spreading are a few common tasks in social network analysis. These tasks play a crucial role in extracting knowledge from networks and solving problems using network data. By analyzing the structure and dynamics of social networks, researchers can gain insights into various phenomena and make informed decisions based on the patterns and relationships within the network.

Centrality [13], degree [14], and betweenness [15] are common measures utilized to understand information flow in a network. Past research have also emphasized utilizing network-level metrics in analyzing information flows in social media spaces. These network-level metrics, which include density [16] and centralization [17], provide valuable insights into the flow of information.

D. Work on Social Network Sentiment Analysis

In order to effectively and efficiently analyze the large amount of data generated by social media networks, sentiment analysis, or opinion mining, is used to identify whether the viewpoint of an author or user regarding a particular subject is positive or negative [18]. It involves the process of extracting meaningful information and understanding the underlying semantics from text using natural language processing techniques, and determining the writer's attitude, which can be positive, negative, or neutral [19].

One popular technique of sentiment analysis is the lexicon-based technique, which involves utilizing a word dictionary where each positive and negative word is assigned a sentiment value. The sentiment of an entire sentence or document is then calculated by summing or averaging the sentiment values of

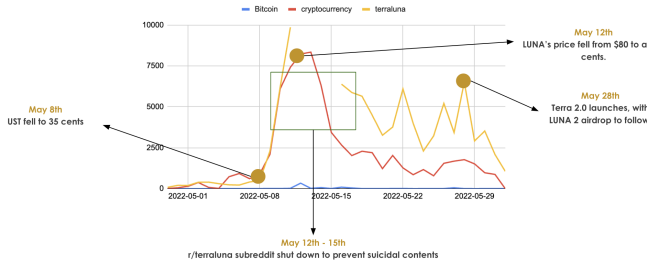


Fig. 2. Volume of Submissions and Comments by Date and Subreddit

the words present in the text. This approach relies on pre-defined sentiment dictionaries, or lexicons, to determine the overall sentiment expressed in a sentence or document. SentiWordNet [20] and Valence Aware Dictionary and Sentiment Reasoner (VADER) [21] are popular lexicons in sentiment.

IV. DATASET

A. Dataset Collection Through PushShift (PSAW) and Python Reddit API Wrapper (PRAW)

For data collection, we utilized both PushShift API Wrapper (PSAW) [22] and Python Reddit API Wrapper (PRAW) [23]. Initially, submissions were pulled using PSAW when it was still live. However, PSAW was made unavailable in May 2023 and further data collection afterwards were done through PRAW instead.

The subreddits chosen for data collection are r/TerraLuna (all submissions and comments taken into account), r/Bitcoin, and r/Cryptocurrency (only submissions and comments with specific Terra (LUNA)-related keywords were taken into account). The time period of the submissions and comments to be analysed is Apr 29th to Jun 1st, 2022. In order to keep the data to a manageable size and subsequently the time taken to retrieve the data to a manageable duration, comment trees were limited to 20 replies. In other words, only up to 20 levels of comment replies to a parent submission will be analyzed.

There were a total of 8,863 submissions and 153,446 comments. From the submission, several details of the submissions were collected, such as number of upvotes, subreddits' names, original poster names (i.e. person who post the submission), and post titles. **Fig. 2** shows the volumes of the submissions and comments for each of the three subreddits by posting date, with some key events being marked.

B. Data Preprocessing

After the dataset to be analyzed is retrieved from Reddit, preprocessing steps were done to clean and remove irrelevant information and details from the submissions and comments' text body. This process utilizes natural language processing and text processing tools including NLTK [24] and WordNet [25].

- First and foremost, stopwords (both from NLTK and additional Reddit-specific and internet-specific stopwords such as *removed*, *https*, and *nan*) are removed from the corpus.

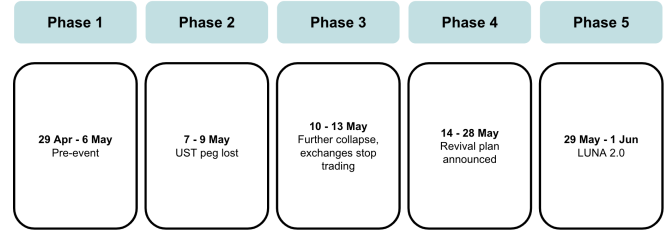


Fig. 3. Timeline

- Words with length of two characters or less are then removed because more likely than not these words will not contribute to the analysis of the corpus.
- All remaining strings in the corpus are then tokenized using NLTK's Punkt module. Tokenization here means the process of splitting a string of text into a list of token or component words.
- Afterwards, only words with occurrence of 5 or more will be included in the corpus and the rest will be removed. This is because the assumption is that words that appear less frequently are not necessarily relevant to the topic being analyzed.
- The remaining words are then lemmatized using WordNet. Lemmatization refers to the process of reducing the different forms of a word to one single form.

V. TIMELINE

Based on how the submissions and comments grew and fell, and how the price of both LUNA and UST collapsed within the month, the whole data can then be roughly split into five distinct phases, as shown on **Fig. 3**.

In further detail, the phases are:

- **Phase 1: Pre-event, 29 April - 6 May:** This phase indicates the dates where the event has not taken place yet, or at least, users on Reddit have not really identified the event happening. Submissions and comments volume is quite low compared to the other phases, and LUNA and UST prices are still quite stable.
- **Phase 2: UST peg lost, 7 - 9 May:** This phase indicates the dates where the collapse started to happen, beginning with the UST's loss in peg to the US dollar. As highlighted by SwissBorg, the collapse was attributed to a coordinated attack by market actors strategically using their capital to destabilize the UST peg and generate profits. Submissions and comments volume started to pick up in all three subreddits. This is true especially on May 8th, where UST price fell to 35 cents.
- **Phase 3: Further collapse and stoppage of trading by exchanges, 10 - 13 May:** This phase indicates the dates where the peak of the collapse happened. After the loss in trust by the crypto community with the project despite announcements to burn UST and mint LUNA in an attempt to save the project was made, both LUNA and UST values dropped drastically, while volume of

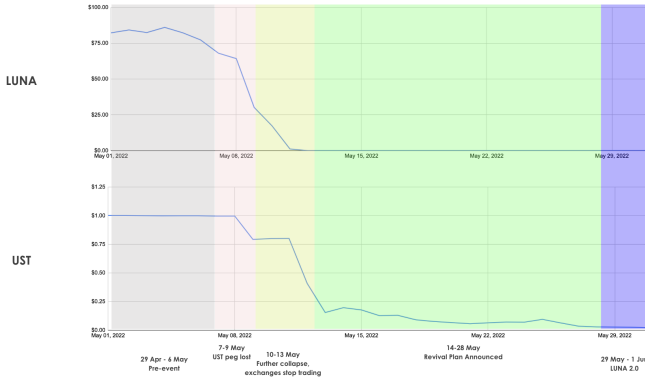


Fig. 4. Price of LUNA and UST throughout May 2022 - phases

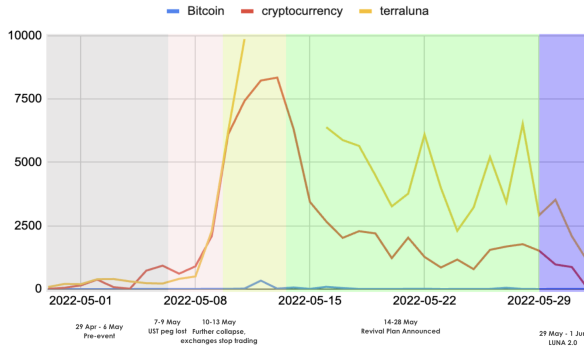


Fig. 5. Volume of Submissions and Comments by Date and Subreddit - phases

submissions and comments within the three subreddits increased significantly. In addition, r/terraluna was shut down starting on May 12th in order to prevent further increase of suicide related contents which started to appear due to the collapse.

- **Phase 4: Revival plan announcement, 14 - 28 May:** This phase indicates the dates where the collapse has already taken place, and Do Kwon announced his proposal to fork Terra without UST, calling the current chain "Terra (LUNA) Classic" and the new chain "Terra (LUNA) 2.0". Submissions and comments volume is consistently quite high throughout the period for r/terraluna, where most of the posts and comments were discussions about this new plan.
- **Phase 5: Terra (LUNA) 2.0, 29 May - 1 June:** This phase indicates the dates where the plan for Terra (LUNA) 2.0 has already been launched, and airdrops for pre-collapse LUNA holders has happened on May 28th. The volume of submissions and comments were somewhat lower compared to the previous phase, but were still quite high compared to phases 1 and 2.

The charts for asset prices as well as volume by day with the suggested phases added in as sections are shown in **Fig. 4** and **Fig. 5**.

VI. METHOD

A. Social Network Analysis

In this study, the preprocessed Reddit submissions and comments dataset is analyzed as a network, where each user is considered as a node, while interactions between users, whether that is a user's reply to another's submission, or a user's reply to another's existing reply to a submission, are marked as edges. As the number of interaction between any two users become more frequent, the edge weights are then made higher.

After creating the network, it is then important to find out users who are considered to be influential or central to the network. Centrality measures has been widely used to identify important nodes in a network [26] [27] [28]. Degree centrality, eigenvector centrality, closeness centrality and betweenness centrality are used to identify important nodes and reveal how information flows within the network.

Each centrality measure is explained as the following.

Degree Centrality is defined as the number of links incident upon a node (i.e., the number of ties that a node has). A node with high degree centrality can be interpreted as more 'central' with the largest amount of link connections to other nodes [26]. Degree centrality is calculated by:

$$C_D(i) = \sum_{j=1}^N A_{ij}$$

Eigenvector Centrality measures the centrality based on how well the neighbouring nodes are connected [29]. A node with high eigenvector centrality means that it is connected to neighbours who are themselves well-connected. The calculation takes into account this importance factor and is calculated by:

$$C_E(i) = x_i = \frac{1}{\lambda} \sum_{j=1}^N A_{ij} x_j$$

Closeness Centrality is a way to detect nodes that are able to spread information more efficiently than other nodes. A node with high closeness centrality can be interpreted as nodes that are able to relay information quickly as it requires less number of edges to reach other nodes [30]. It is calculated by:

$$C_C(x) = \frac{1}{\sum_y \sigma_{yx}}$$

Betweenness Centrality is a measure of centrality based on the number of shortest paths that pass through the corresponding node. A node with high betweenness centrality can be interpreted as more important as it acts as a node that can control information flow in a network [31]. It is calculated by:

$$C_B(i) = \sum_j^n \sum_{k>j}^n \frac{g_{jk}(i)}{g_P j k}$$

These centrality measures characterize the network structure in the study and better interpret the important nodes that have more influence in the network.

For this particular case, eigenvector centrality is the centrality measure that is used for analysis and determination of the top users, since it measures how good in terms of quality

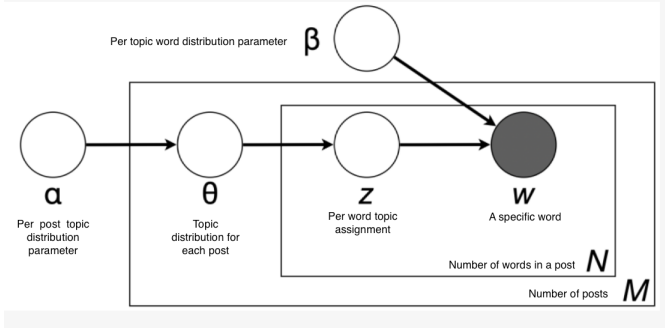


Fig. 6. Latent Dirichlet Allocation (LDA)

a user's interactions with others are (interacting with other 'high quality' users). In other words, it allows for connections between users to have a variable value, so that connecting to some "higher quality" users has more benefit than connecting to others.

After finding out the top users, the sentiment and topics pertaining to these top users can then be identified, and therefore insights can then be drawn regarding how the Terra (LUNA) collapse event took place within Reddit based on the attributes surrounding the top users.

In addition to identifying the top users on an overall level, top users on a phase by phase basis are also identified, in order to find out how the topic and sentiment evolved throughout the phases based on the central actors in each of the five phases.

B. Sentiment Analysis

The preprocessed Reddit submissions and comments dataset's sentiments were also analyzed and classified. For this purpose, the VADER Sentiment Analyzer, a rule-based sentiment analysis tool and lexicon designed for social media [21], was applied to the dataset.

The VADER Sentiment Analyzer was employed to classify the preprocessed submissions and comments into three categories: positive, negative, or neutral.

C. Topic Analysis

In this study, Latent Dirichlet Allocation (LDA) [32] was employed for topic analysis to uncover hidden structures and underlying topics within the corpus of submissions and comments. LDA has been widely used in various fields, including business, technology, and society, to effectively analyze textual data. Its versatility and capability to reveal topics in an unsupervised manner make it a valuable tool for exploring and understanding large sets of text data.

LDA treats each corpus as a vector of words, following a "bag-of-words" approach. It utilizes a three-level Bayesian probability model, where each corpus is associated with a probability distribution over topics, and each topic has a probability distribution over words. The graphical representation of LDA is illustrated in Fig. 6.

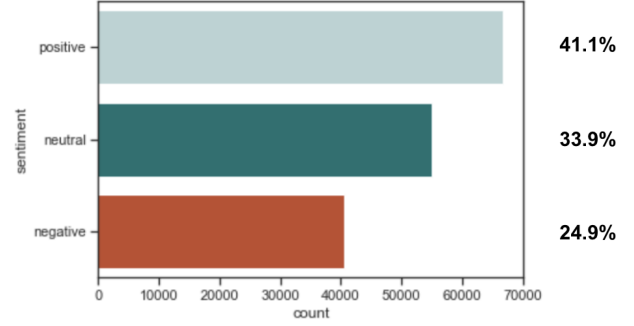


Fig. 7. Overall Dataset Sentiment

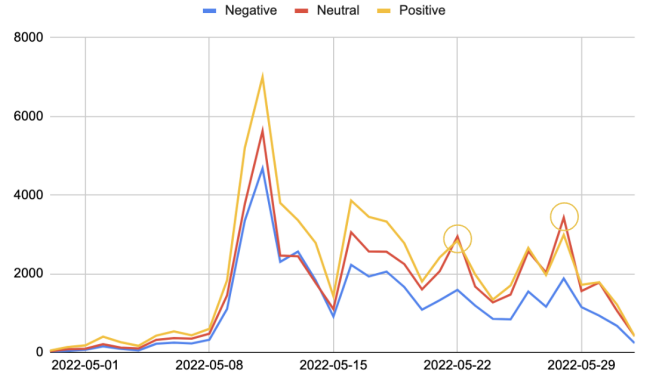


Fig. 8. Sentiment by Day

VII. ANALYSIS

A. Overall - Sentiment

In terms of how the overall dataset shapes up, the sentiment is mostly positive, as shown in Fig. 7, with 41% of all submissions and comments being categorized as positive. Despite this, the amount of negative posts are not insignificant, with 25% of them considered to be negative.

When looking into the sentiment splits by day as shown on Fig. 8, the majority of days are dominated by positive sentiment, except for May 22nd and May 28th (circled in the figure). Both these dates belong to the fourth phase, or the period where the collapse has happened, the revival plan has been announced, but has not launched yet.

B. Sentiment by Phase

Looking into the split of sentiments by the five different phases, the proportions are somewhat quite similar, with a few key differences that are quite telling in terms of how the discussions within each phase formed.

As shown in the chart on Fig. 9, phase 1 saw the highest positive sentiment, most likely due to the collapse not taking place yet during this period. Nevertheless, the amount of positive submissions and comments dwindled down as the event progressed from one phase to another.

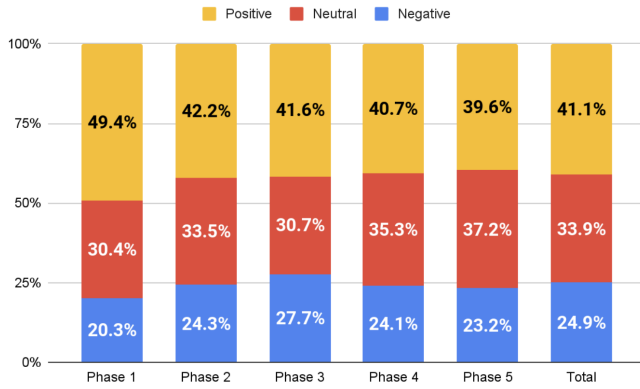


Fig. 9. Sentiment by Phase

User	Eigencentality	Volume (posts/comments)	Net Sentiment	Topic Keywords	Period of peak activity
CommieFunkoPopFan	0.14	667	+4.6%	terraluna, money, people, get, like, burn, buy, coins, think, good	May 21st and 22nd
candiedassballs	0.13	483	+7.8%	terraluna, Do Kwon, money, make, like, burn, people, mod, dont, would	May 22nd
D33N5	0.12	442	+11.7%	terraluna, would, get, million, twitter, tokens, lol, wallet, burn, money	May 22nd and 25th
Atsac1993	0.12	351	+8.9%	terraluna, wallet, post, like, even, one, would, burn, still, people	May 18th and 22nd
Bucksaway03	0.11	262	+0.8%	terraluna, people, going, shit, money, still, like, even, market, got	May 11th to 15th

Fig. 10. Top 5 Users - Overall

The highest negative sentiment proportion was seen in phase 3, as expected, since this phase is when the peak of the collapse happened. Additionally, phase 5 saw the highest proportion of neutral posts, most likely due to the nature of topics and discussions in this phase being more informational and related to the updates on the revised plans for Terra (LUNA) 2.0 and the airdrops for existing holders.

C. Overall - Top Users

On an overall level, there are five users with higher eigenvector centrality compared to others, as shown in **Fig. 10**. Four of these users (*CommieFunkoPopFan*, *candiedassballs*, *D33N5*, and *Atsac1993*) were most active during phase 4, while the fifth user *Bucksaway03* posted the most during phase 3 and early phase 4.

All top users expressed positive sentiment, ranging from very slightly positive (+0.8% net sentiment for *Bucksaway03*) to somewhat more positive (+11.7% net sentiment for *D33N5*). In terms of topics, top topics for these users revolve around the mechanics of the LUNA revival plan announced by the founder Do Kwon (mainly for the four users most active during phase 4). Most of them also commented and answered to posts asking questions regarding the revival plan.

D. Top Users by Phase

When looking into the data by each individual phase, top users within each phase can be identified. The attributes (shown in **Table I** and **Table II** surrounding the discussions

where the top users are involved in can inform us on how the topics were formed and also how they evolved along the way.

For **Phase 1**, only one user shows a significantly higher eigenvector centrality compared to others (*SilverHoard*), and this user posted useful and positive Crypto-related advices and made comments of similar sentiment and context on other users' posts. Other than *SilverHoard*, no other users' eigencentality were significantly high enough to be analyzed further.

For **Phase 2**, there were two users with significantly higher eigenvector centrality, although sentiment-wise they are quite different. *gnarley_quinn*'s posts are mostly positive in terms of sentiment, showing concern for others and optimism. Topic discussed include the impacts of the UST depegging and whether people should hold or sell their LUNA holdings. On the other hand, *Odlavso*'s overall sentiment is negative and pessimistic. The user commented on LUNA and UST's decreasing prices, and how the situation is bad for him/her and other holders.

For **Phase 3**, there were three users with higher eigenvector centrality. Two users posted less, but showed higher centrality and higher net sentiment. *hearsdemons* and *SkepticalCryptoDude* made comments/posted submissions regarding what they think is happening with the collapse, shared advices to others, and expressed how they sympathize with those who lost a lot. Another top user *Underrated321* took a more pessimistic approach by focusing on the negative side of the collapse i.e. liquidation volume and the Terra LUNA project being fundamentally flawed.

For **Phase 4**, the three top users with highest eigenvector centrality are the same users who tops the centrality across all phases (*CommieFunkoPopFan*, *candiedassballs*, and *D33N5*). All these top users also showed net positive sentiments, with topics include details on the revival plan and responses to questions posted by other users. Top topics from top users revolve around the the LUNA revival plan announced by the founder Do Kwon. Most of them also commented and answered to posts asking questions regarding the revival plan.

For **Phase 5**, there were three top users with considerably highest eigencentality compared to others; these users are: *Best_Satisfaction308*, *Jabulon*, and *Historical-Camel-168*. Top topics from top users revolve around optimism with LUNA 2.0 and their plans regarding it.

VIII. CONCLUSION, LIMITATIONS, AND FUTURE WORK

A. Conclusion

The collapse of the Terra (LUNA) blockchain protocol presented a crucial opportunity to delve into the inner workings of network structures and user sentiments in the cryptocurrency community. The discoveries offered valuable insights into the conduct of influential users during times of crisis and emphasized the significance of thoughtful and informative contributions in the crypto space.

Throughout the event's progression, the network structure undergoes changes, leading to the emergence of influential users who shape the topics being discussed. Generally, as the

TABLE I
TOP USERS BY PHASE

Phase	User	Eigencentality	Number of Posts	Net Sentiment (VADER)	Topic Keyword (LDA)
Phase 1	SilverHoard	0.69	28	+13.6%	market, people, much, money, like, control, crypto, make, potential, see
Phase 2	gnarley_quinn	0.57	33	+9.6%	terraluna, btc, started, price, depeg, stables, left, peg, sold, increased
Phase 2	Odlavso	0.35	14	-6.9%	Terraluna, usd, gif, giphy, crypto, live, right, price, worth, supply
Phase 3	hearsdemons	0.20	11	+7.0%	terraluna, bitcoin, like, people, crypto, coins, stable, coin, one, money
Phase 3	SkepticalCryptoDude	0.18	37	+5.9%	Crypto, terraluna, market, think, could, term, people, lot, nothing, crash
Phase 3	Underrated321	0.16	88	-0.7%	terraluna, billion, money, people, gif, would, leverage, hours, like, liquidated
Phase 4	CommieFunkoPopFan	0.21	604	+4.2%	terraluna, money, people, get, like, burn, buy, coins, think, good
Phase 4	candiedassballs	0.20	482	+7.7%	terraluna, Do Kwon, money, make, like, burn, people, mod, dont, would
Phase 4	D33N5	0.17	355	+11.1%	terraluna, twitter, million, lol, tokens, would, get, money, people, status
Phase 5	Best_Satisfaction308	0.36	138	+10.8%	terraluna, binance, new, think, money, trading, know, time, open
Phase 5	Jabulon	0.20	80	+10.9%	burn, terraluna, like, dokwon, even, supply, would, could, think, transaction
Phase 5	Historical-Camel-168	0.20	23	+5.8%	terraluna, people, dokwon, money, community, png, buy, crypto, new, get

TABLE II
TOP USERS - SAMPLE VERBATIM

User	Verbatim
SilverHoard	<i>"first looked into it in 2015, but only really did my homework and got into it late 2017. 2018 was my baptism by fire. been here ever since."</i>
gnarley_quinn	<i>"what were the terms again? it had to stay above \$80-ish? and the bet was like \$10m or something right?"; "sorry man. I'm sure it is a very bitter pill to take right now."</i>
Odlavso	<i>"best of breed? more like sh*t out of luck, am i right?"; "this wouldn't be a loss, this would be the end for luna"</i>
hearsdemons	<i>"guys, the fear-greed index is at 12, extreme fear. we're seeing a lot of fear, a lot of uncertainty. the luna situation has only exacerbated what was already a depressed market. but veteran investors are looking at this unmoved."</i>
SkepticalCryptoDude	<i>"i genuinely feel for luna holders. it looked so strong and seemed as if it would be the best performing alt in the bear market, and wham. crypto is wild"</i>
Underrated321	<i>"exactly. if they allow for such a mistake to happen, then it deserves to die and not be invested in"; "holy f*ck the liquidations are now at \$2.75 billion"</i>
CommieFunkoPopFan	<i>"if your intention is to swing trade it, you should probably wait for a lower entry point. but you do you"</i>
candiedassballs	<i>"dokwon tweeted, deploying capital, steady lads luna is going down a lot even after the burn, dont worry though its all according to plan, no one panic, its okay!"</i>
D33N5	<i>"yes, in time, i'm going to hold my bag for the next few years and see how it develops, looks like i have a vested interest in the luna chains for the next couple of years now anyway lol"</i>
Best_Satisfaction308	<i>"That's true. then just hope they have a plan. I guess there is a reason that most of the exchange supported luna 2"</i>
Jabulon	<i>"someone make a good burn proposal for luna1 pls. just double the tx fees and send those straight to burn, and let all validation burn from now on."</i>
Historical-Camel-168	<i>"we are making the comeback of the century! luna 2.0 will not get anyones money back as evidence by the failed launch because the trust is gone but as a community we can make luna classic succeed!! sold my luna 2.0 at 8 dollars to buy lunc at 0.00008 and burned it!"</i>

volume of discussions increases, more central figures come into play, although this isn't always the pattern observed. Phase 4 stands out as a period where top users maintain a prominent presence across the entire timeline, despite Phase 3 having the highest daily volume of discussions.

What's intriguing is that these top users are not known for having extreme sentiment polarities; instead, they tend to express their thoughts, knowledge, and information in a lucid and detailed manner. Upon analyzing all phases, it becomes apparent that the overall sentiments of these top users lean mostly towards the positive side, though only slightly. Moreover, their language is characterized by well-constructed and comprehensive responses, which exemplifies their expertise and active engagement with the topics under consideration.

B. Limitations and Future Work

Some limitations and potential future work identified from this study include:

- Event detection and timeline/phase identification was done manually instead of automated; this might render the study as more difficult to apply to other events. Future work surrounding this issue might include implementation of automatic abnormal event detection [33], [34].
- VADER is a lexicon and rule-based tool and is therefore dependent on the individual words used in the corpus. It is limited in contextual understanding, and it may have some inaccuracies when fed with complex sentences or domain-specific languages. Further work might benefit from implementation of more complex sentiment analysis tools such as usage of neural networks [35].

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