THE RISE AND FALL OF THE NFT EMPIRE: THE SOCIAL PHENOMENON OF NON-FUNGIBLE TOKENS

by

Kellie Dalton

Submitted in partial fulfilment of the requirements

for the degree of Master of Information

at

Dalhousie University

Halifax, Nova Scotia

April 2023

Dalhousie University is located in Mi'kma'ki, the

ancestral and unceded territory of the Mi'kmaq.

We are all Treaty people.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Non-fungible tokens (NFTs) burst into popular culture in 2021 with the $69 million dollar sale of Beeple's artwork *Everydays: The First 500 Days*. Since then, this potentially disruptive technology created new digital markets that have been making waves both in incredible successes and steep failures. This paper explores NFTs as a social phenomenon. Using user-generated data from Twitter, I apply frequency tables, sentiment analysis, and community clustering to begin filling in a knowledge gap by mapping who were engaging with NFTs, what topics and discourse these users were discussing, and what sentiments the users possessed about NFTs throughout their discourse.

LIST OF ABBREVIATIONS USED

ADA	Cardano, cryptocurrency
API	Application Programming Interface
BNB	Binance coin, cryptocurrency
BSC	Binance Smart Chain
BTC	Bitcoin
dApp	Decentralized application
DeFi	Decentralized finance
DEX	Decentralized exchange
DOGE	Dogecoin, cryptocurrency
EOS	Cryptocurrency
ETH	Ether, cryptocurrency (can also refer to Ethereum, the blockchain)
FinTech	Finance technology
FTM	Fantom, cryptocurrency
FTX	FTX Trading Ltd.
FUB	Flovatar Universe Builder
HODL	Hold On for Dear Life
IDO	Initial DEX Offering
NFT	Non-fungible Token
NST	Ninja Squad Token, cryptocurrency
SFUND	Cryptocurrency
SHIB	Shiba Inu Coin, cryptocurrency
SOL	Solana, cryptocurrency
XRP	Cryptocurrency
XTZ	Tez, cryptocurrency

GLOSSARY

Application Program Interface (API): A software that defines and allows a two-way communication between a service and a user.

Blockchain: Also known as distributed ledgers, blockchains take blocks of data and disseminates copies of the data block through a network. These copies are linked together by mathematical algorithms called hashes. Any changes made to a data block changes the hash, causing the chain to break. This allows for an auditable and traceable database network.

Cryptocurrency: A decentralized economy made up of digital and virtual currencies. Uses cryptography in lieu of a central facilitating organization to verify and secure information.

Decentralized Applications: Applications that run on blockchain networks instead of a central storage location, usually providing cryptocurrency services.

Decentralized Finance: A digital financial system that utilizes blockchain technology to remove a needed central facilitator (like a bank) to exchange cryptoassets.

Decentralized Information Systems: A network for storing and transferring data without the need of a central facilitator to verify and initiate transactions. For example, many financial transactions go through a central banking organization which initiates, verifies, and enacts the transaction. In a decentralized system, the bank is not needed as the central facilitator and the transaction can be direct peer-to-peer.

FinTech: Financial technology, the implementation of technology that improves the efficiency and effectiveness of financial organizations that provide financial services to consumers.

GameFi: Video games that utilize blockchain networks to create financial incentives and rewards for its players through crypto tokens (like NFTs) and cryptocurrencies.

Minting: The term used when creating a unique token, like a NFT, on a blockchain.

Non-fungible token (NFT): A unique, digital item. Created by “minting” data onto a blockchain network turning them into one-of-a-kind record of data that can be sold and bought. Can be any type of media, such as art, music, .gifs and movie clips.

Rug-pull: A scam where a NFT creator or developer advertises a project with investor benefits but shuts the project down after all funds have been collected. Also known as pump-and-dump schemes.

ACKNOWLEDGEMENTS

Thanks to Dr. Philippe Mongeon, who was willing to take this project on as my supervisor. I had never undertaken a quantitative research project before, let alone one that turned out to be this huge, and your faith in me helped see this project to the end.

Thanks to both Dr. Colin Conrad and Dr. Qi Deng, my committee members, who took the time to provide thoughtful and supportive comments to make this thesis the best it could be.

Thanks to the School of Information (SIM) faculty, who were always so kind and checked in with me over the year to discuss my progress and how I was doing.

And, finally, thanks to my SIM friend squad, who helped me more than they know with their support, kindness, late night Discord messages when I needed the company, the reminders to drink more water, and for always being there when I needed them.

CHAPTER 1. INTRODUCTION

1.1. BACKGROUND

Since 2021 when non-fungible tokens (NFTs) exploded into popular culture thanks to the artist known as Beeple and his $69 million artwork *Everydays: The First 500 Days* (Kastrenakes, 2021), the technology has been driving research into the ways information transfer and ownership can be shaped and changed through its processes. NFTs, and the blockchain technology that enables them, have been making waves as a potentially disruptive technology (Doorsamy et al., 2020). The uses of NFTs have been expanding just as fast as its user base, through the innovative capabilities the technology presents. Although NFTs are a newer phenomenon, they are intrinsically linked to the longer established blockchain technology, meaning they are subjected to a volatile and dynamic financial landscape that runs on cryptocurrency. These characteristics of dynamism and volatility are mirrored in the variety of innovative NFT uses and in the opinions held by those involved in the technologies discourse. While NFTs only recently became a huge phenomenon, NFTs and the blockchain technology that enables them are far from new.

1.2. WHAT IS BLOCKCHAIN AND NFT?

Also known as “distributed ledgers” (Gayvoronskaya & Meinel, 2021, p. 5), blockchain technology at its core is a database infrastructure. The database is created through a decentralized system that relies on a zero-trust model where the identity of all users is not necessarily known and verification of the information is collaborative. The

decentralized nature of blockchain is noted in the absence of a central facilitator, relying on the users to verify information as it gets disseminated through the network. As a record gets created, the data block gets copied and sent over the entire network where each receiver validates the information and locks it in by accepting. Each copy gets chained together through time-stamping cryptographic hashes (Gayvoronskaya & Meinel, 2021). These hashes are secure mathematical algorithms that are near impossible to deconstruct or re-create. When a block in the chain is altered in any way, the entire chain fails as the hashes no longer link together in a cross-referencing series, denoting that unauthorized alterations were attempted.

NFTs are a type of data block enabled by a blockchain network. They are created (referred to as "minting") and stored on a blockchain as a unique, one-of-a-kind (non-fungible) digital item (or token). As NFTs are data records, they can be linked to any type of media such as images, text, music, .gifs, video, and physical objects. The NFT record itself is unique and it can be bought and sold for cryptocurrency. Upon creation, NFTs can be disseminated (whether for profit or not) by the creator with un-editable terms of use, sale conditions, and ownership information. As ownership records, the value in NFTs is granted in the owning of the record instead of placing value in the object the record is linked to. This gives rise to a new concept of "digital scarcity" in an environment that rarely has anything original, where media and information are disseminated infinitely over the Internet.

1.3. THE RECENT STATE OF NFT USE

Due to constant innovations in use, NFTs and blockchain are shaping new decentralized, democratic ways of recordkeeping and transactions. Many of our information systems have historically been governed by central organizations acting as third-party facilitators (Gayvoronska & Meinel, 2021). Someone, somewhere else, manages our information the moment we entrust an organization to verify, hold, transfer, and use our information. Our information in these types of systems becomes out of our hands and decisions are being made about it beyond our control by others.

One of the ways the new system enabled by NFTs was utilized is by content creators who have been using NFTs as a new method of commerce in multimedia markets. These markets have capabilities of a new system where creators retain their information and financial autonomy over the creative outputs (Patrickson, 2021). Recently, however, with the NFT market crashing (Redman, 2022), the questions that have been raised about the validity of these markets are seemingly being answered. These answers are also being fueled by the arrests of scammers (Cascone, 2022) which corroborate opinions of NFTs simply being a haven for money laundering and fraud (Patrickson, 2021). Companies like Spotify (Roth, 2022), Starbucks (Castrodale, 2022), and Square Enix (Tassi, 2022) have attempted to tap into NFTs through purchasable virtual products, services, and exclusive memberships to promote their brands. Celebrities and sport teams have also turned their brands into NFT digital collectible games (Dirchi, 2022) as an extension of real-world trading card collections (Stevens, 2022). Criticisms abound surrounding these uses of NFTs and opinions have led to accusing celebrities and companies of jumping onboard the newest get rich scheme and conning their audiences into pyramid scheme scams (Folding Ideas, 2022).

Other uses have made news headlines that show different ways NFTs as a system of transferring and storing information can be utilized. In the beginning of April 2022, residents living in Shanghai going through a pandemic lockdown that infringed on human rights took to minting photos and videos of the state of their lives as NFTs to circumvent Chinese government censorship (Ye, 2022). Other personal uses have seen couples getting married through the minting of NFTs as their wedding rings with the marriage certificate getting created as a block of data on a blockchain (Sarkar, 2022). The discussions around NFTs gives a sense of the clash of opinions around their use and the potential to disrupt (Cornelius, 2021) the current systems of information transactions and proof of ownership.

1.4. RESEARCH IMPLICATIONS AND QUESTIONS

This research will focus on exploring the topics and opinions present in the global discussions around NFTs through a social network enabled by Twitter. While there were many social media networks, websites, and communication platforms that were utilized by NFT users, as the market flourished these communities became fragmented around specific projects or websites. Many projects and communities had separate communication methods through networks like Discord servers and Reddit subreddits. Many of the blockchain networks and marketplaces had multiple online communities all with different purposes and users; for example, Ethereum has a list on their website of official community channels which is made up of 8 different forums, 11 different chat rooms but only 2 Twitter accounts (Ethereum, 2023). With the NFT market crash, many of these communities have become inactive or defunct. In previous iterations of this

research, the incredibly active Discord community for the subreddit r/NFT was going to be utilized as a data source, however, that community closed May 3, 2022, all messages deleted, and has not since reopened.

With the fragmented nature of the NFT community over multiple communication platforms as well as the increasing inactivity of many of these communities, a more stable and widely used single social media platform was desired. Twitter was selected as this one social media network to study. Twitter was one of the main used social media platforms by the cryptocurrency communities (Critien et al., 2022; Nizzoli et al., 2020; Park & Lee, 2019) and as NFTs are closely related, creators and investors of NFTs continued to use Twitter. Twitter also provided a large, easily accessible aggregate dataset obtained through their application program interface (API). Other commonly used communication platforms like Discord do not allow the mining of data through their API access as doing so breaks their developer policy (Discord, 2023).

There appears to be a disconnect between the theoretical promises that NFTs can achieve that are proposed by researchers and the actual realities surrounding NFT users that are getting reported on in the news. The main questions this research will aim to answer are:

1. How has the Twitter community engaged with the NFT discourse over time?
    a. What are the main themes in the NFT discussion within the Twitter community over time?
    b. How have the sentiments of the NFT Twitter community changed over time?

c. Who have been the main communities discussing NFTs on Twitter and how have they been engaging with the NFT Twitter discourse?

This research intends to begin filling in a knowledge gap of the social contexts behind NFTs and how the users may have influenced the technology's moments of success and failure. When this thesis research first began, the body of research into NFTs as a user driven social phenomenon was almost non-existent. There have been a small number of related studies published within the first few months of 2023 that started to begin filling this research gap, and this thesis intends to contribute to that growing research pool. Even with the knowledge of the NFT market crashing while conducting this research, there is still merit in it. This exploration into the social perspectives of the users themselves acknowledges their strong contribution behind NFTs dance with success. Many researchers failed to quantify the social aspects of NFT usage by leaning more into a focus on NFTs just as financial entities with an end game of profit. Understanding who was aiding the financial success of NFTs and how they were engaging with the technology to create that success creates valuable guidance for future NFT use and, perhaps more likely, any future financial disruptive technologies.

CHAPTER 2. LITERATURE REVIEW

2.1. DISRUPTIVE TECHNOLOGIES

Organizational sectors are seeing immense technological advancements (Kimani et al., 2020; Mahmood & Mubarik, 2020; Postelnicu & Calea, 2019) that obscure the lines between the physical and digital worlds (Schwab, 2017; Soh & Connolly, 2021). In this collision of worlds, radical changes to the social, political, and economic structures of society are occurring in rapidly progressive ways (Chou, 2019; Mahmood & Mubarik, 2020; Martinelli et al., 2021). Societal frameworks constantly shift as previous institutional structures struggle to maintain a footing as new technologies disrupt the status quo (Doorsamy et al., 2020; Kimani et al., 2020). Some of this technological shake up has shown that it can give back users' autonomy over their digital lives. Social sectors need to keep up with technological expectations to work efficiently and effectively (Mahmood & Mubarik, 2020; Postelnicu & Calea, 2019), navigating the new landscape of disruptive technologies and user needs (Kimani et al., 2020).

Technological innovation can be labelled as disruptive when its implementation has immense power to uproot and force change in the pre-existing systems of organizations, operations, and functions (Doorsamy et al., 2020; Kimani et al., 2020; Umar et al., 2021). Disruptive technologies possess new elements and processes that can shake the status quo of the mainstream structure (Bower & Christensen, 1995). There are numerous technologies that were once labelled as disruptive that are commonly used in the world today, such as cloud computing (Kimani et al., 2020; Martinelli et al., 2021) and big data (Doorsamy et al., 2020; Kimani et al., 2020; Martinelli et al., 2021). The

disruptive abilities of technologies such as blockchain (Doorsamy et al., 2020; Kimani et al., 2020), cryptocurrencies (Doorsamy et al., 2020; Kimani et al., 2020; Umar et al., 2021), and smart contracts (Doorsamy et al., 2020) are still being evaluated as their adoption becomes more widespread, seeping into many sectors trying to capitalize on the technologies promises.

Innovation can be considered a technological competition, both between organizations vying to stay ahead of one another and in social systems that cyclically fade out for others (Adner, 2002; Chandrasekaran et al., 2022; Hopster, 2021). Technologies are also not inherently disruptive (Hopster, 2021). Usually incited by some form of user demand (Adner, 2002; Danneels, 2004; Hopster, 2021), potentially disruptive technologies tend to be adopted first by periphery groups (Christensen, 1997; Hopster, 2021; Palmié et al., 2020) looking for an alternative to the status quo. As an alternative, this does not always mean the new technology is better than the current systems upon adoption (Adner, 2002; Christensen, 1997) and the users of the conventional systems tend to resist technologies that are not immediately better to the systems they already know (Bower & Christensen, 1995).

The periphery group that begins using the innovative technology tests and explores its capabilities, culminating either in the technology being re-phased out because of failed expectations or the technology begins evolving to eventually push out the current system through gradual further adoption (Adner, 2002; Bower & Christensen, 1995). The social conditions (Adner, 2002; Liu et al., 2020; Schuelke-Leech, 2018) surrounding the adoption of technology that becomes disruptive is a focus in research that explores the discussion of innovation beyond organizational and business values. Due to

the nature of adoption being a social phenomenon, understanding the social conditions of disruptive technologies can be conducted through the exploration of social media (Best, 2020; Bruns & Burgess, 2012; Starinsky, 2021). Bruns and Burgess (2012) examine how Twitter is now one of the largest communities for the dissemination of information and discussion of news stories. The dissemination of news and events over Twitter is reliant on the community engaging with the stories as it gets disseminated through ever-linking social networks. There is an ease of information dissemination over social media, due to users becoming initial reporters of events and the accessibility of information (Bruns and Burgess, 2012). In terms of Twitter's ability to aid technologies becoming disruptive, social media creates an accessible, networked community that aids in the evolution and subsequent further adoption through information sharing and discussions (Choi et al., 2020; Jeong et al., 2019; Liu et al., 2020) that reach more wide-spread attention. Social media has also become a part of the cycle of innovation (Schuelke-Leech, 2018). This cycle of innovation is driven by circumstances of social context that lead to the adoption of disruptive technologies in spaces where there are opportunities for change (Chandrasekaran et al., 2022; Danneels, 2004; Hopster, 2021).

For the sake of the following research about NFTs, there will be a focus on cryptocurrency and blockchain technologies as they are two integral structures. Kimani et al. (2020) attribute blockchain as being "one of the most important technological innovations in the 21st century" (p. 2). Blockchain creates a system that can be used for dissemination, transaction, and the storage of information that does not need a third-party facilitator. A process like this replaces the current longstanding financial and information transfer systems (Gayvoronskaya & Meinel, 2021) that we are accustomed to. With the

absence of a governing third-party facilitator that is expected to hold, verify, and initiate transactions, freer reign of control is given to the individual parties in protected peer-to-peer transaction capabilities (Gayvoronskaya & Meinel, 2021). A variety of applications are enabled by blockchain such as cryptocurrency tokens like NFTs (Bao & Roubaud, 2022).

2.2. THE ADOPTION OF NFTs

Much of our information is streamed through centralized networks where third-party organizations store, regulate access, and facilitate transfers (Gayvoronskaya & Meinel, 2021). Many of these dominant systems have come under fire in the face of wavering trust and usage hinges on a lack of sustainable alternatives (Cornelius, 2021; Draper & Turow, 2019; Morrow & Zarrebini, 2019). Blockchain and NFTs, through a decentralized model, propose a disruptive system by offering an alternative. The need for a third-party facilitator is removed and control of information remains in the hands of the users (Gayvoronskaya & Meinel, 2021; Morrow & Zarrebini, 2019). With the notion of blockchain being a disruptive technology, the emergence of a new market is a common result of adoption of the new system (Bower & Christensen, 1995) which is seen in the NFT markets.

Artists are one of the main groups to adopt NFTs (Kugler, 2021; Patrickson, 2021; Whitaker, 2018). The NFT art market provided artists with a new market system in place of structures that were not always looking out for their best interests. Patrickson (2021) mentions the “capacity to help automate, incentivize and authenticate global trade” (p. 585) leading to a widespread re-structuring of the creative industry. NFTs

allowed artists to potentially earn more without the restrictions of the current art market systems, while reaping the protective benefits of blockchain technologies. The digital element means there is no limit to how many people can consume works of art and the decentralized system opens to buyers everywhere (Gayvoronskaya & Meinel, 2021). NFTs being enabled by blockchain allows for the use of applications like smart contracts that could be attached to the terms of sale in the NFT record. In the traditional markets, the moment a piece of work is sold it is no longer tied to the creator beyond their name being attributed to it (Kugler, 2021). A smart contract can imprint unchangeable re-sale parameters that get automatically triggered when the sale conditions are met (Cornelius, 2021; Patrickson, 2021; Whitaker, 2018). Suddenly, artists now have a permanent stake in their art which never existed before (Whitaker, 2018). It meant that artists had a chance at a more guaranteed, constant professional income from all their career sales, meaning they can focus more on their professional creative output rather than needing to find supplementary work when necessary. These royalty payments are also quicker and trigger instantaneously with the smart contract replacing a tedious commission system between artists and galleries, who are not always on top of their transfers of funds (Kugler, 2021).

Another main group of adopters were video gamers as the market of GameFi grew in popularity. Microtransactions in video games have become a common business model, especially in games that are deemed free-to-play, to create a source of revenue for the creators (King & Delfabbro, 2019; Neely, 2021; Zendle et al., 2020). Microtransactions allow video gamers to pay money for digital items, that are non-transferrable and have no financial value once purchased, to use in game. With the increase in the inclusion of microtransactions came many criticisms of ethics (Neely,

2021; Xiao & Henderson, 2021), the enabling of gambling or abnormal purchasing behaviours (King & Delfabbro, 2019; King et al., 2020; Tang et al., 2022), gaming addiction (King et al., 2020), and financial exploitation (King et al., 2019). GameFi are like these microtransaction markets, taking those digital items and turning them into NFT tokens (Chainlink, 2023), utilizing blockchain systems to attach a cryptocurrency value to them. By turning the in-game items into NFTs, players keep a higher stake in their game tokens, providing an open transaction market with less developer interference, and the ability to provide player financial incentives to play (Chainlink, 2023) as their in-game purchases are considered tradable financial assets unlike before.

2.3. THE HYPE AND CRASH OF NFTs

NFTs provided users a new entry point into the cryptocurrency market, providing new opportunities for participating in what was a valuable, financially strong market in 2021 and for the beginnings of 2022. Gartner, a leading technology research agency (Gartner, 2022), produces a yearly report on new and emerging technologies on what they refer to as the "hype cycle." As of 2022, NFTs began the descent from the second phase of innovation, the "peak of inflated expectations" (Gartner, 2022), to the third phase of the cycle of the "trough of disillusionment" (Gartner, 2022). A major factor of this crash was driven by the bankruptcy of FTX, one of the leading cryptocurrency exchange platforms, in November 2022, which was caused by of a financial crash in the spring of 2022 (Ramirez, 2023). The bankruptcy of FTX further sent the cryptocurrency markets spiraling into incredible financial lows (Ramirez, 2023) and further company bankruptcies. In December 2022, the ex-founder and CEO of FTX, Sam Bankman-Fried,

was arrested on charges of wire fraud, conspiracies to commit further wire fraud, commodity fraud, securities fraud, conspiracy to commit money laundering, and conspiracy to defraud and violate U.S. campaign finance laws (Powell, 2022).

Using the Gartner Hype Cycle as a framework to conceptualize the current research in NFTs can produce an overview of expectations and realities. As will be explored in the remainder of this literature review, the academic literature about NFTs presents a mixture of opinions and counter arguments surrounding NFTs and their potential to be successful. Two overarching, albeit overlapping, main uses of NFTs in the literature are NFTs as methods of transaction and NFTs as records of ownership.

2.4. NFTs AS TRANSACTIONS

NFTs have enabled a new cryptocurrency economy of digital collectibles, artworks, gaming microtransactions, and many other digital assets (Bao & Roubaud, 2022; Horky et al., 2022; Hosseini et al., 2022; O'Dwyer, 2020). These new digital assets follow a similar trajectory to the larger established cryptocurrency market, which has a high ceiling of financial power (Bao & Roubaud, 2022) that allows for new ways to monetize and transfer digital objects (O'Dwyer, 2020). Along with the high financial ceiling, the NFT market is also prone to the inherent issues of uncertainties that the cryptocurrency market also possesses. These issues are due to the explosive and volatile market trading tendencies along with minimal legislations that covers this new digital-only space (Bao & Roubaud, 2022) while also possessing an unclear system of value and pricing schemes (Dowling, 2022; Horky et al., 2022; Mackenzie & Bērziņa, 2021). Studies have explored how cryptocurrency value is tied closely to social media trending

activity, which further influences the volatile tendencies of the cryptocurrency economy (Nizzoli et al., 2020; Park & Lee, 2019). Sellers and investors use social media, such as Twitter, as a main means of communication to advertise, influence, track, and discuss market characteristics leading to the NFT community being deeply rooted in social media (Nizzoli et al., 2020; Park & Lee, 2019). With this online social dynamic being integral to the NFT market and the markets valuation, there are many widespread issues that have been able to take hold such as rampant scams and fraud, money laundering, and exploitation (Cornelius, 2021; Dowling, 2022; Hughes et al., 2019; Valeonti et al., 2021) due to the ease of posting malicious information to unsuspecting investors over social media.

Rampant scams and fraud became increasingly common that target investors, such as rug-pull scams and password phishing attempts. Criminal charges have begun being laid against these scam and fraud attempts, like in the Mutant Ape Planet rug-pull attempt, which saw the creator releasing a NFT project promising investors certain benefits with no intention of providing them before abandoning the project once the funds had been collected (United States Attorney's Office, 2023). Money laundering and market exploitation increased along with the popularity of NFTs and have been tracked by many third-party researchers. Wash trading, which leads to market manipulation, became more prevalent (Chainalysis, 2022) in NFT markets despite being illegal. Wash trading happens when the buyer and seller are the same person (or the buyer and seller are in an agreement) to flip assets at artificially raised prices due to manufacturing demand. In keeping with criminal activities, money laundering also became a rising issue

(Chainalysis, 2022); like real-world money laundering instances, investors would purchase NFTs with illicit funds and then flip their assets later for legit cryptocurrency.

Patrickson (2021) finds that the NFT market provides "the promise [of] efficient transactions, greater accountability of trade and increased and direct payment for creative enterprise" (p. 1). NFTs are valued through their artificial scarcity (Bao & Roubaud, 2022; Cornelius, 2021; O'Dwyer, 2020; Valeonti et al., 2021), a new concept that was never quite possible in digital-only markets previously. Originality is the main characteristic of determining value in collectible items, which is hard to replicate in digital spaces where copies and reproductions are as easy as a couple of mouse clicks (Mackenzie & Bērziņa, 2021). NFTs give creators access to a new open market for a wide range of content that otherwise had barriers and limitations in traditional settings (Bao & Roubaud, 2022; Kugler, 2021) while utilizing the blockchain capabilities of transparency and auditability (Cornelius, 2021; Ferone & Della Porta, 2022). In this new market, however, are issues of high cost of use and the need for advanced digital literacy, both for sellers and buyers. Digital literacy is necessary when it comes to using cryptocurrency wallets and other crypto applications (Valeonti et al., 2021). The need for digital literacy also spreads into the navigation of misinformation and inaccurate explanations on what cryptocurrencies and NFTs were, how they work, and what exactly is being transferred between people, all the while also needing to be alert for digital scams and fraud. Malicious sellers were known to take advantage of unaware and uninformed buyers who were caught up in the hype of "pump and dump" (Hamrick et al., 2021) schemes with the promise of quick, high profits (Mackenzie & Bērziņa, 2021; Patrickson, 2021). Additionally, there are concerns with the future accessibility of

purchased NFTs, which are reliant on the blockchain servers they are minted on to remain operational (Valeonti et al., 2021). Finally, research into the environmental issues of cryptocurrencies has become a burgeoning field, with concerns over the incredibly large environmental footprint the technology produces to sustain the systems (Alonso et al., 2021; Sang et al., 2022; Truby et al., 2022; Valeonti et al., 2021).

2.5. NFTs AS RECORDS OF OWNERSHIP

A main principle behind the valuation of NFTs rests in the traceable records enabled by the blockchain network. NFTs are "tradeable rights of digital assets" (Hosseini et al., 2022, p. 1) embedded as records of authenticity and provenance that are supported by the unalterable nature of the blockchain network (Hosseini et al., 2022; Whitaker, 2018). In a digital environment where infinite reproductions of content are possible with "right click + save" to personal storage space, authenticity of original creative properties can be almost impossible to prove (Chohan & Paschen, 2021; O'Dwyer, 2020). With NFTs being considered as "tradable rights" (Hosseini et al., 2022, p. 1), having ownership of the one unique, and authentic, NFT record strengthens the idea of artificial scarcity that creates its value (Bao & Roubaud, 2022; Chohan & Paschen, 2021; Pinto-Gutiérrez et al., 2022; Valeonti et al., 2021) through the notions of rarity and exclusivity (O'Dwyer, 2020).

As a record of authenticity, it confirms that no unauthorized changes or alterations have been made to the record and there is a clear provenance of who has owned it (Chohan & Paschen, 2021; Mackenzie & Bērziņa, 2021). The opportunity of unchangeable and clear records of ownership is heralded as a chance to further protect the

values of intellectual property from theft and fraud (Mackenzie & Bērziņa, 2021; O'Dwyer, 2020). The opportunity, however, seems to be falling short for similar reasons of scams, fraud, and increased artwork theft (Cornelius, 2021; Mackenzie & Bērziņa, 2021; Patrickson, 2021; Zeilinger, 2018). Similarly, to the financial nature of NFTs as transactions, fraud and scams also affect NFTs ability to be records of ownership. Investors are buying into fake NFT projects where the records of ownership end up meaning nothing of value (Chainalysis, 2022). NFTs did not stop art theft either; there are many instances of stolen art that was minted as an NFTs and put up for sale by someone who was not the original creator (Beckett, 2022) ignoring all copyright and intellectual property laws.

There is also a significant lag between current legal recordkeeping systems and how the policies deal with digital records and their validity (Cornelius, 2021; Mackenzie & Bērziņa, 2021). While the merit of blockchain and NFT record capabilities exist, they currently do not meet the standards of recordkeeping best practices. While the NFT records cover the expectation of authenticity, the unalterable nature of the records goes against the quality of the living record that allows necessary information to be added and modified throughout the record life cycle (Cornelius, 2021). Since NFTs contain contracts, such as terms of sale, they also can be scrutinized through the foundations of contract law. The standard contract form contained in NFTs misses some of the regulatory qualities of recordkeeping contracts, alluding to these missing qualities as perpetuating skewed business relationships (Cornelius, 2021). Where NFTs were being considered by some researchers as a new democratic method of proving and transferring information, the embedded contracts are not as democratic as previously thought

(Cornelius, 2021) with little additional law or policies to support it. While the benefits of NFTs unchangeability and traceability as records are ideal to recordkeeping, until the lag between policy and legislation becomes more bridged, there is a hesitancy for current owners of traditional contracts and copyrights to make the switch to the digital-only environment (Cornelius, 2021; Hosseini et al., 2022).

2.6. NFTs AND THE GLOBAL NARRATIVE

As explored, the previous academic research presents a mixture of opinions between the promise of NFT technology and the realities of its current use. There is a focus in previous research utilizing social media in investigating certain topics like marketing and business opportunities (Lansiaux et al., 2022; Park & Lee, 2019; Naeem et al., 2021; Soussan & Trovati, 2020; Saura et al., 2022), political discourse (Porwol et al., 2018; Zubiaga et al., 2019), user behaviours (Yin et al., 2015; Zou et al., 2015), and global disasters (Das & Dutta, 2021; Saltzman, 2017). Where there is an abundance of research into how social media drives and dictates the cryptocurrency and NFTs market values (Chursook et al., 2022; Critien et al., 2022; Kraaijeveld & De Smedt, 2020), utilizing the global discussion forums (Jeong et al., 2019; Schwab, 2017) for a more socially driven analysis of the NFT community fills a current gap in the research.

2.6.1. The Use of Social Media in Studies – An Analysis

An understanding into how social media can be utilized to explore the global discussion supports building the foundation of this research. With how continually ingrained social media is in our everyday lives (Chen et. al, 2017; Ghani et al., 2019), the

popularity of social media use has led to massive quantities of data being created by users (Barradas et al., 2022; Chursook et al., 2022; Ghani et al., 2019; Lansiaux et al., 2022). People are constantly using social media platforms to microblog, communicate, and consume media (Chen et al., 2017). With how widespread the use of social media is, a digitally connected network for information dissemination and open discussion (Best, 2020; Bruns & Burgess, 2012; Chen et al., 2017; Starinsky, 2021) is created with a global reach (Best, 2020; Starinsky, 2021). The content generated by the users of social media offers a plethora of opinions, collective influence, and behaviours that can be explored as data in a variety of research contexts and uses.

The usage of social media data in studies about NFTs is mostly in the form of research into the cryptocurrencies that give NFTs their value, revolving primarily around financial and market topics. There is an abundance of research surrounding topics of social media's impact on business trends (Barradas et al., 2022; Shahzad et al., 2022), cryptocurrency market values (Chursook et al., 2022; Lansiaux et al., 2022; Naeem et al., 2021; Park & Lee, 2019), and financial trends (Critien et al., 2022; Li et al., 2021; Ngo, 2022; Nizzoli et al., 2020). These previous studies all come to determine that there is a direct connection between marketplace valuation and the social media activity around certain cryptocurrencies at certain times.

Even with the abundance of business-oriented research outcomes through data science analysis in the cryptocurrency context, there is still the underlying thread of socially created data in a globally connected community. User-generated social media data is still opinion driven in a socially constructed discussion forum that is built on user interaction. Looking at NFTs through a social lens, as opposed to a financial lens, opens

the discussion that allows analysis into NFTs as a user-driven phenomenon. By keeping the focus on the social nature of the data, the opportunity to explore how the users created the boom of NFTs will open discussion into why the technology was seen as having so much potential. The socially focused approach will also present the chance to explore the downside of the NFT phenomenon culminating in the almost plummeting crash which created an incredible stark contrast to the NFT boom in such a short time.

CHAPTER 3. METHODOLOGY

3.1. GENERAL METHODOLOGICAL APPROACH

As explored in the literature review, social media is an application people use constantly in their everyday lives in growing amounts. The data it generates is immense and accessible, making it a growing source of data for many fields of research. This research will use social media data to explore NFTs as a social phenomenon. Utilizing the data created by the community allows for exploration into the NFT discussion from those directly interacting with and utilizing the technology.

There are a large variety of social media applications available, with many people using multiple applications concurrently. In this study, Twitter was chosen as the social media application to analyze. As mentioned previously, Twitter is a large component to the NFT and cryptocurrency markets. Research into how Twitter trends dictate the market and financial contexts are already discussed as the most common research outcomes (Nizzoli et al., 2020; Park & Lee, 2019). There is little previous research that focuses on the social contexts of the users on Twitter to explore the user sentiment and behaviour of those who have adopted NFTs as a system.

Twitter, being both a popular social media platform for the NFT and cryptocurrency communities (Critien et al., 2022; Nizzoli et al., 2020; Park & Lee, 2019) and being one the largest social media platforms (Naeem et al., 2021), holds a wealth of user-generated data about NFTs. Through an exploration of this data, an analysis around the discussions about NFTs can explore the themes of discourse, how NFTs were being used, by whom NFTs were being used, and what issues plagued NFTs. By focusing on

Twitter, an active community of users and engaging members can be targeted for the data collection.

This research also uses elements from the digital humanities in its framework. Digital humanities is an interdisciplinary research field by nature, situated at the crossing of the traditional discipline of humanities and the new landscapes created by technology (Luhmann & Burghardt, 2022). The influence of digital humanities on this research is evident in the desire to explore NFTs as a social phenomenon through digital information systems by using computational data analysis techniques. While this research does not fully adopt the taxonomies of digital humanities studies, the prevalent themes of digital-only items and digital culture are influential to the purpose of this research.

The outcomes of this research will strive to fill a research gap in a space that is dominated by business-oriented research outcomes. If disruptive technologies become disruptive through the intersection of innovation, social context, and user adoption, research into the social network created by that intersection can prove useful to analyze social and economic structures. The social context surrounding the rise of these technologies are reflected in the trends and discourses (Giachanou & Crestani, 2016; Sailunaz & Alhajj, 2019) that can be observed through the social network.

3.2. DATA SOURCE AND COLLECTION

The data source used for this study was Twitter. As previously discussed, Twitter was a main social media platform used by the cryptocurrency communities and, by extension, the NFT communities (Critien et al., 2022; Nizzoli et al., 2020; Park & Lee, 2019) as they were closely related. While there were many other communication methods

and applications being used by the community, many of them did not have the same accessibility to the user generated data for research purposes. Twitter had a large volume of explorable user-generated data that was made accessible by the company for research purposes.

The access to the data was granted through the Twitter Developer portal, where academic researcher access was obtained for this project. This allowed access to the Twitter application programming interface (API) and the ability to collect a large sample of tweets. An API is software that allows applications to connect to each other through established classifications and protocols. Through the granted access with the Twitter API, the backend metadata of tweets became accessible. It made it possible to extract the desired data through pre-determined endpoints, which act as call functions to tell Twitter what data was wanted to create the aggregate data set used for this research. Due to time constraints, the timeline for the collected sample of tweets was January 1st, 2021 to October 31st, 2021; a total of 10 months which contains the start of the popular culture rise of NFTs and into the peak of NFT activity on Twitter. Finally, tweets were collected from June 2022, the month of the market crash, to compare and map the changing of topics and trends over time, making the total amount of collected data of about 11 months.

With the access provided through the Twitter Developer portal, tweet data was collected through the Twitter API using twarc2, a Python library that runs by command line prompts. Tweet data was obtained through searching hashtags for this research. Hashtags are community created and community used indexing keywords. Due to hashtags being community created, there is a wide variety of hashtags used by the NFT

Twitter community that also create sub-communities based on cryptocurrencies, market websites, and specific projects. Tweets were collected by searching the hashtag "#nft" and this choice in hashtag was made for numerous reasons. As a general hashtag, the search was open and inclusive of all tweets related to NFTs. The abbreviation of NFT is more commonly used than "non-fungible token" since the community is internet savvy to the point where abbreviations dominate the related jargon. Using a general hashtag also prevented both the over-focus and omission of specific sub-communities. Focusing on specific NFT uses, like NFT art, would have created a fragmented look at the overall NFT community. Using cryptocurrency specific hashtags would also have led to the gathering of non-NFT related tweets, potentially reducing the focus of the intended analysis.

Through collecting data by using twarc2, the data was exported as JSON data files. Due to the number of tweets, data was pulled at two-week intervals per command line prompt. The final number of tweets collected was 13,622,106.

3.3. DATA PROCESSING AND CLEANING

With the JSON files collected and flattened, the files were then pushed to a PostGres database for storage, access, and readability through a Python script. Since Twitter data is unstructured (Barradas et al., 2022; Chursook et al., 2022; Curiskis et al., 2020), meaning it has an incompatible internal data structure with analysis tools, the JSON files collected needed to be converted into a structured database format which PostGres provided. Each tweet had multiple metadata variables, many of which were not

required by the analysis methods. Due to this, table 1 outlines the data fields that were kept for each tweet for this research's analysis.

Table 1. Data variables of each tweet

Field	**Description**
Tweet_id	ID tag of tweet, assigned when pushed to PostGres server.
Created_at	Date and time tweet was posted.
Text	Body text of tweet.
Slice	Time period assigned to tweet, based on date posted.

The hashtags of each tweet were extracted into a separate data table for analysis. This extraction of the hashtags was done through a R script that extracted all hashtags within the tweet text and assigned them to the associated tweet_id into an expanded table, as shown in table 2.

Table 2. Examples from the expanded hashtag data table

Tweet_id	**Hashtag**
102802	#SNN1
102802	#NFTs
102827	#NFT
108282	#NFTGiveaway
102828	#NFT
102830	#Sorare
102830	#NFT
102830	#Ethereum
102830	#FantasyFootball
102831	#cryptoart
102831	#digitalart

With the data being user-generated, there is little content standardization which is seen in the variety of text within each tweet. To aid in clarity of analysis, the removal of some textual elements in the tweets was necessary. Many of the tweet texts contained

URLs and @ mentions, which were removed to prevent random strings of URL characters or usernames from appearing in some of the analysis methods. Hashtags were removed from the tweet texts to prevent their inclusion in the analysis of terms being used in the discourse with the intention of being used in a separate analysis. Emojis and other special characters were not removed from the data to aid in the sentiment analysis, where having the additional context may be necessary. Further, a small handful of tweets contained Unicode characters, however, the amount of these tweets was insignificant enough to not need to exclude them from the dataset. Table 3 shows examples of the cleaned tweets.

Table 3. Examples of cleaned tweets

Tweet_id	**Created_at**	**Text**	**Slice**
1	2021-01-01 00:00:16	Wishing everyone a happy, healthy, peaceful and prosperous New Year from Team Terra Virtua! 🤗 🎉 Thank you again for joining us on this exciting journey and here's hoping 2021 delivers everything you wish for!	hype
5729723	2021-06-04 11:46:52	Theese Bonsai trees are so cute 😋 #NFT #NFTcomunity #BonsaiNFT	peak
8393425	2022-06-10 03:40:11	RT @WoobirdsNFT: 🦉 Hooot Hoot! 🦉 The time has come. We're now SUPER READY to make these lovely owls fly towards you! 🚨 #Woobirds FREE MINT i…	crash

For analysis that looked at the total usage of certain terms, variations of the terms were determined and aggregated into one single instance, for example “NFTcollectors” and “NFTCollectors” were tallied together into “NFTcollector." Doing this allowed for more accurate usage counts and clarity in the visualizations. In addition to this aggregation, all variations of “NFT” (like “NFT” and “nfts”) and the phrase “RT” were

removed from some of the analysis techniques. This was done on the implication that "NFT" would overwhelmingly always be the most used term, as it was the hashtag used to pull the data from the Twitter API in the twarc2 query. "RT" was also removed for similar reasons in the analysis of most used terms, as the phrase designates a retweet opposed to a term or topic and appeared quite commonly which detracted from the overall analysis. The original tweet in a retweeted post remained in the analysis as part of the overall discussion. As will be further explained in the appropriate data analysis sections, there were also a couple of isolated cases where certain terms were subsequently removed from the analysis as obvious outliers to allow more clarity. This was selectively done, however, on a case-by-case basis as it would be incredibly difficult to do this level of cleaning to all the data.

Finally, during the hashtag analysis, some tweets did not have any associated hashtags, but were included in the dataset through linked conversation IDs through retweeting of hashtags. These tweets were removed before analysis. Hashtags also had many variations of the same term (eg. #NFTCommunity and #nftcommunity) and were aggregated into a single hashtag for subsequent analysis.

3.4. DATA ANALYSIS

With this cleaned dataset, the quantitative methods of frequency tables and sentiment analysis were utilized through R. The data analysis of community clustering was performed through Gephi. The dataset was broken down into three groups: the "hype" period which features tweets between January 1st, 2021 to May 31st, 2021; the "peak" period which starts at the half-way point of the collected data featuring tweets

from June 1st, 2021 to October 31st, 2021; and the “crash” period which features the tweets collected from June 2022. These data chunks were determined by using the Gartner Hype Cycle as a conceptual framework, to support a focused analysis to explore the desired outcomes, as well as allowing the creation of a timeline to explore how topics and sentiments of the NFT Twitter community may have changed over time.

3.4.1. Frequency of Terms

Using frequency tables, a deeper look into the discussions of the NFT Twitter community was conducted. By creating frequency tables of the terms and hashtags commonly used by the NFT community, an exploration into the distribution of terms in the community discourse could occur. The analysis method enabled looking at topics and trends as an aggregate grouping by determining how many times certain terms were used throughout the entire dataset. By creating clustered groups of most used terms, trends and themes of discussion will emerge from the distribution and usage of certain terms. The analysis method was done to both the text of the tweets and the community used hashtags to create a well-rounded discussion of how the NFT Twitter community were engaging with each other about the technology.

Upon running the frequency tables, the term “amp” was one of the top terms. The term “amp” has a few potential contexts in varying relevance. Table 4 shows a sample of tweets that have “amp” within their text.

Table 4. Examples of tweets that mention "amp"

Tweet_id	**Text**
8132	RT : I wonder when the money, finance & business shows will start talking.

Tweet_id	Text
59930	Thank you for placing bids on 'Personality Amalgamation'• & on two avatars 'Digital Persona II & III'• on These are still open for bids & 'Personality Amalagamation'• includes an optional 1/1 signed print.
2402019	Look what I found! Dan Otsuki - Equilibrist (2012) - UNLOCK & CLAIM collectible
3239921	New NFT art & Scams
3838353	RT: Digital prints created with the aid of AI Follow, like & share to see more
4467232	"Tulips" my first Hic & Nunc Only 7 left on
4632379	2nd Giveaway! After our first winner, here is the second giveaway for Holo Series! You'll get Holo "N.024 | Veer". 1. Follow 2. Like & Retweet 3. Tag 3 The winner will be announced on Sat, 17th.
5651606	I need travel, it is an obsession. I try to remember something on my past travels but images are confused, distorted. A mental trip. Project 100% original & unique.
6045303	RT: We are launching Follow, like & retweet this Tag your most desired Fanzyâ€¦
6886136	RT: Drop your ETH address, Like, Retweet & Follow RT Pinned will send someone ETH or a LOOK THROUGH MY PAGE TO SEE PROOF

While amp does have a relevant context as a platform for asset transfers, most of the amp usage appears to be a common text error where ampersands are replaced with the HTML code &amp. Due to this, the term “amp” was removed from the dataset.

3.4.2. Sentiment Analysis

Sentiment analysis deals with exploring the opinions of the community creating the data (Martinez-Camara et al., 2012) and categorizing the data into positive, negative, and neutral emotions (Kontopoulos et al., 2013) through the sentiment in the language used. This analysis aided in exploring the discourse and ideas surrounding NFTs, as well

as keeping the analysis rooted in the users' opinions and attitudes towards NFTs. Two sentiment analysis lexicons were used: the AFINN Sentiment Analysis lexicon and the Word-Emotion Association (NRC) lexicon.

Both the AFINN and NRC lexicons are two of the simplest but most used sentiment analysis lexicons (Silge & Robinson, 2022). The AFINN lexicon was specifically designed to analyze sentiment in tweets, which originally contained about 2400 words but that since has grown (Nielsen, 2011). The creator of the AFINN lexicon built on existing sentiment analysis lexicons by identifying their main limitation in a lack of included Internet jargon (Nielsen, 2011). The AFINN lexicon is a compilation of words that assign an emotion sentiment score to each word that appears in the lexicon. The associated score is a number between plus five and negative five and is totaled overall between all words in the tweet as a final score output.

The NRC lexicon currently has 14,182 words included in its lexicon (Mohammad, 2010) that associates words with 2 different sentiments and 8 different emotions, four positive and four negative. The NRC lexicon was the first algorithm to do word-emotion associations in addition to the sentiment category and because of this, has the largest number of words compiled (Mohammad, 2010). Where the AFINN lexicon was constructed for Twitter data, the NRC lexicon is widely used on a variety of data sources in different disciplines, which includes digital humanities and social science (Mohammad, 2010). The NRC lexicon aimed to incorporate the emotional context behind words, opposed to a simple "yes" or "no" algorithm (Mohammad & Turney, 2013). By using the two together, the sentiments of the tweets overall and the sentiments of specific words in the tweets can be looked at together for a more robust analysis.

Upon running the sentiment analysis algorithms, two of the most used negative words were found to not be negative in context. One of these words, “discord,” is shown in table 5 with a small sample of tweets.

Table 5. Examples of tweets that mention 'discord'

Tweet_id	Text
5788	IMPORTANT. If you have some of my in your wallet you Can receive 100 $TBS per. Claim them to my discord server and you will receive a special role who give you access to others $TBS each week. Don't miss them !
26006	Get ready to enter the second edition of Legends tournament with unique cards to earn on ! Join discord now to register now
41193	Just about 3 hours until the historic fireside chat over on discord. I hope you will come join in for some great conversation about and more!
80442	Track 9 of 10 is available on Track 9 - Arke - Decentralized - Harvest 10 ex. - 0.1 ETH Provide 100 $ARKE when bought¸• More infos : Discord : All :
947623	RT: I will be inviting some of you to a private investing/collecting Discord server for. If you want an invite link
5000183	Humans! We are bringing back the classic Letters to the Editor for our comic. If you have a burning question or unadulterated heaping of praise you would like to bestow upon the Grand Reptilian Council post it in our discord. Hail Draconis! $RPTC
5509037	Today's post is brought to you by who shared this original painting of theirs in our community Discord. To me, this reminds me of the cityscape from Vancouver. What's it remind you of? Stay tuned for us to release our platform for Instagram creators
5831062	Join HODL on Discord!
5832383	Just over 2 hours until discord drop! You will want to be here for this!
13135817	DinoSaviors are coming. Join our Discord now if you don't want to miss out on getting our super cute and pink role! Who knows what benefits it will give you in the future?

Discord is a popular VoIP and messaging application that is commonly used by the NFT community and does not hold the negative connotation that the sentiment

analysis algorithm is assigning to it. The other word that has similar issues with the algorithm missing the context is “limited,” shown in a few sample tweets in table 6.

Table 6. Examples of tweets that mention "limited"

Tweet_id	Text
147	2020 in review: Cointelegraph art team limited edition drop
648	Legend says, if 1 of the chrome card will sell out, a legendary edition will be released. As for the chrome card, that limited special edition one will be released very soon, stay updated!
29062	Lamborghini Huracan LP 620-2 Super Trofeo will be the 5th of 21 digital artwork, limited to 5 Release on Jan 25th at only €¢â€¢â€¢ $RARI
74941	Y'all be sure to check out the Atomic Card No. 1! it's only a limited amount for you to check out, so don't miss it! autobuy is set at 0.077 ETH via
82155	DigitalArt Day 16/365 - "Abrus" Limited Edition 1/1 on
451834	Available Now, 5/5 Minted Limited Edition Crypto Eggs, First edition plucked straight from the clutch. Crypto Eggs Fire - Too hot not too drop
746807	Limited series of 100 loveable kitties. Each piece is animated to purr-fection!
800517	Exclusive "God of ETH: Motus" by Ivan Kv (feat. and). Limited Edition! Find the artwork on Link:
5883597	RT : Collect your favorite Action Figures next week before they run out! Limited Edition/Supply!
12881868	RT: GM fam, hope you are ready for crypto weekend! We finnaly picked winner of LIMITED 1/1 on twitter:

Due to the NFT tactic of marketing through digital scarcity, projects and collections are overwhelmingly created and promoted as limited run. The sentiment analysis algorithms associate negative emotions to the word “limited.” These negative connotations do not quite match the intentions of the word in this context was subsequently removed from the data. The term “limited” is quite positive based on this context since it directly relates to the inherent value in owning a limited edition NFT.

3.4.3. Clustering for Community Detection

Community detection allowed for the identification of sub-communities within the NFT community and looked at how these groups were engaging with NFTs through community discourse. This method of analysis generated a network of the participating user groups to determine who is interacting with whom and through what topics, by creating a network of relationships based on the usage of community established hashtags (Hu at al., 2016). Weighting is assigned to each hashtag as a node, which then connects to other nodes through the relationships created by common occurrences of hashtags together (Ullah & Lee, 2017). This network aids in identifying common themes and trends in the discourse by visualizing how sub-communities were interacting with each other and through what hashtag topics. To assist in the clarity of analysis, a new data variable was created in the PostGres server's data table called "combined_id" with the intention of aggregating similar instances of hashtags together into one total, for example, #NFT and #nfts were given the same hashtag id of 348,583 to link them together. This process of assigning one hashtag ID to similar hashtags was done manually to the top 400 hashtags, which was around when the hashtags began to be more unique.

With this new data variable, R was used to create two .csv files of edges and nodes, which are the two needed elements to create a visualized network. The nodes are composed of the hashtags and the edges make up all the references and connections between hashtags. These two .csv files were then imported into Gephi, an open-source software that creates a variety of visualization graphs and networks (Gephi, 2022). In Gephi, both .csv files were imported into a new project through the data laboratory tab which then created the linked network analysis. The use of Gephi allowed for a variety of

spatialization algorithms to be applied for the creation of a network. In the subsequent network analysis, the Force Atlas 2 layout setting was chosen to cluster the groupings together and then expanded out with the node labels removed due to the size of the network. The method utilized the Louvain community detection algorithm, which detected the clusters by the weight of the links between the community nodes (Blondel et al., 2008). Through this method, the nodes that are strongly linked together cluster together, where nodes that are only loosely linked push away.

CHAPTER 4. RESULTS

The collected tweets have two different communicative characteristics involved in the data: the text of the tweet itself and any associated hashtags. The text of the tweet reflects what each individual user was posting to add to the NFT discourse while the hashtags acted as indexing keywords that facilitated engagement with the community.

4.1. TOPICS AND HASHTAGS IN THE NFT TWITTER COMMUNITY

Figures 1, 2, and 3 show the top forty terms used during the “hype,” “peak,” and “crash” periods. To aid in the analysis, many of these terms fall into three loose categories: NFT project terms, promotional terms, and community terms.

Figure 1. Top forty terms of the "hype" period

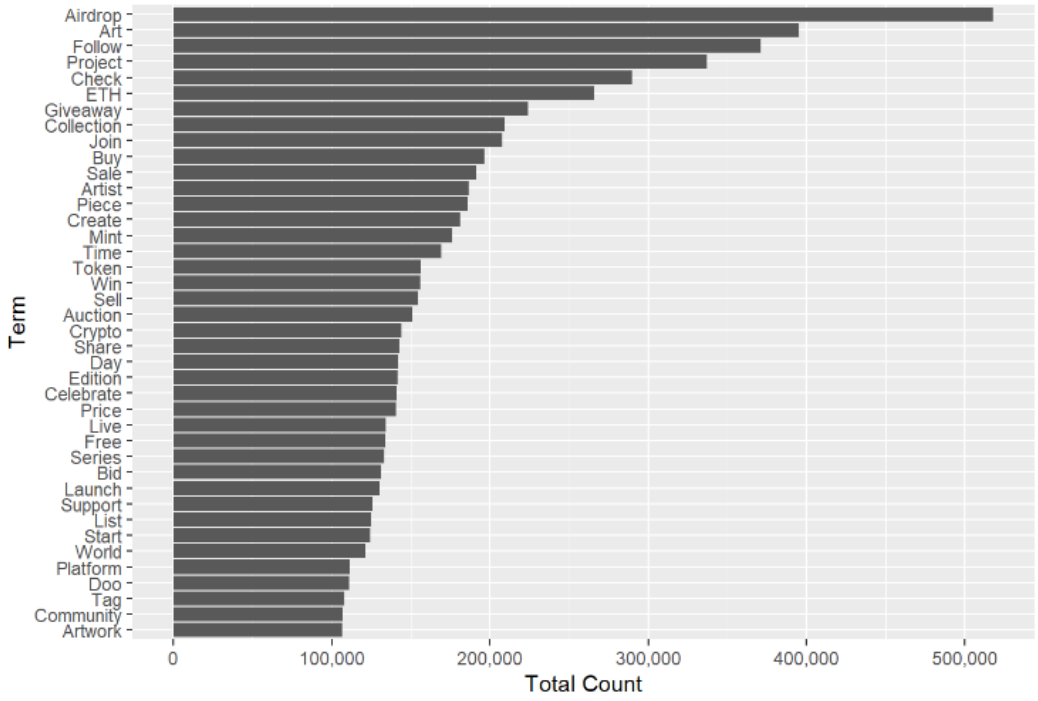


Figure 2. Top forty terms of the "peak" period

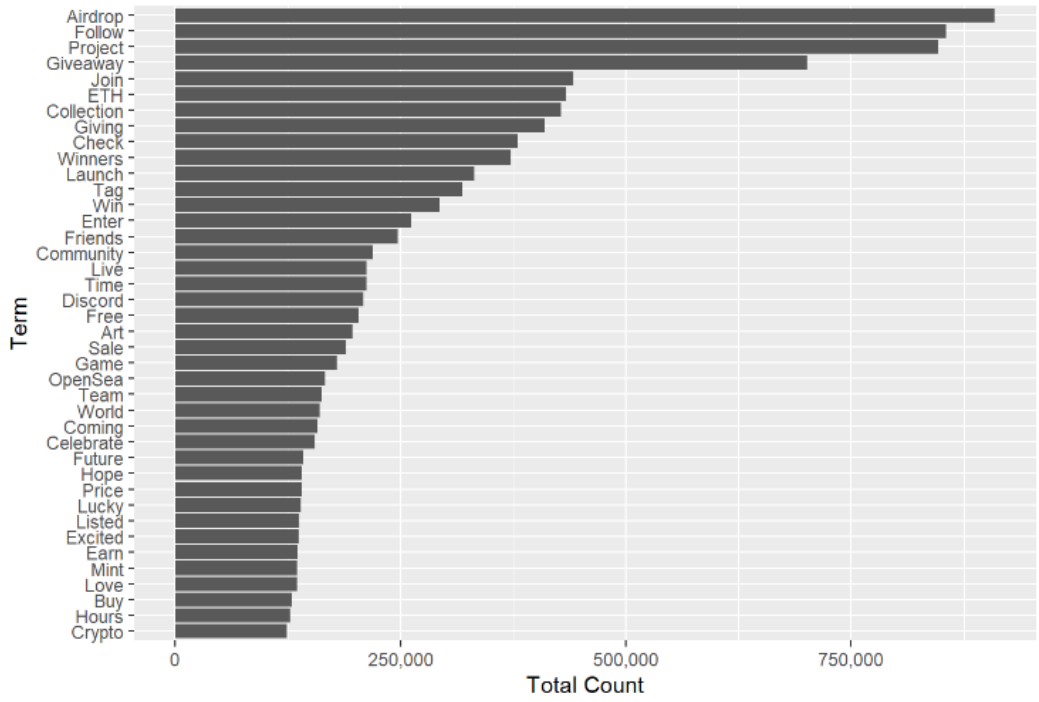
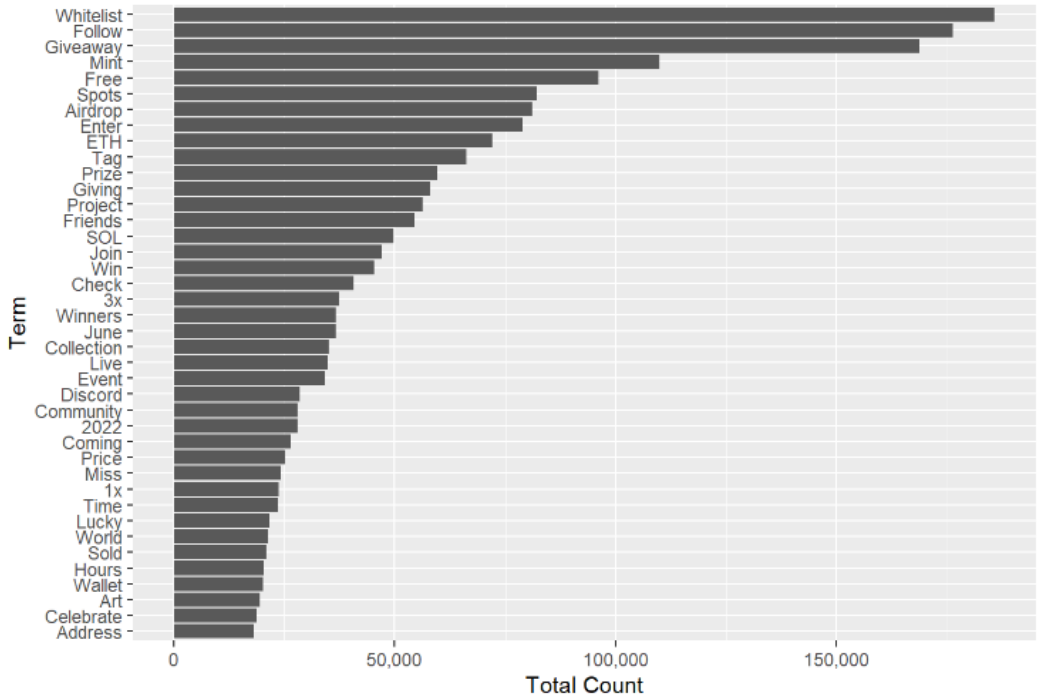


Figure 3. Top forty terms of the "crash" period



The first category is terms that relate to NFT projects. Starting with the “hype” period, “art” is the most used term in this category, and the second most used term

overall, with 395,201 instances. Artists are mentioned in the top forty with 186,357 instances used and is the only term to reference the creators themselves. The term "project" is the forth most used term in this period's top forty terms with 336,972 instances, which could have referred to art projects, game releases, decentralized application (dApp) launches, or NFT related websites. At 181,277 instances used, the term "create" is the fourteenth most used term which relates to the act of creating the many NFT projects that creators were producing. Related to the creation of NFT art projects, "collection," "series," and "piece" were all descriptors of the art projects that artists created, whether as a group of works or standalone creations. In this group of three terms, "collection" was used the most at 209,133 instances and "series" was used the least at 133,045 instances.

"Mint" and "token" are included in the forty top used terms, with 175,980 and 156,491 instances respectively, which are related to the creation of NFTs. The creation of NFTs is called minting, which is the process of binding something to a blockchain to create the NFT record. Both "crypto" and "ETH" are present in the top forty terms at 144,273 and 266,054 instances respectively; NFTs were crypto tokens and had cryptocurrency value while ETH, which stands for Ether, was a popular cryptocurrency, that ran on the Ethereum blockchain. The mention of the community itself was at the bottom of the top forty terms with 107,153 instances.

With the expectation of the "peak" period to follow a similar topic trajectory heading into the height of NFT activity on Twitter, there was a large drop in usage of terms related to NFT projects compared to the previous period. Only four terms are consistent with the "hype" period with one new term being introduced. The term

"project" is now the third most used term with 846,785 instances. "Art" which was the second most used term in the "hype" period is now in the bottom half of the most used terms at twenty-seven. The general term "crypto" dropped in usage to being the fortieth used term but "ETH" jumped in use during this period with 433,353 instances. Finally, "collection" also increased in use during the "peak" period with 428,375 instances. The remaining term in this category, "game" did not appear in the top forty of the previous period, being used 179,083 times in the "peak" period.

Moving on from the height of the NFT activity on Twitter into a period during the start of the NFT market crash, four of the top forty terms related to NFT projects remained commonly used. The term "mint" continues to be in the top forty terms in the "crash" period. "Project" and "collection" also remained consistently in the top forty terms used among all three periods. The term "ETH" continued to be present in all three periods, however, another specific blockchain network appears for the first time during the "crash" period in SOL, which stood for Solana.

The second category of terms are related to the promotion of NFT projects. In the "hype" period, the term "airdrop" is the most used term with 517,957 instances. Airdropping was a common marketing strategy for new art and gaming NFT projects. Airdrops had creators divide up their projects among collectors and then releasing the works simultaneously to their crypto wallets, almost always for free. The intention of these airdrops was to drum up interest, create scarcity, and digital exclusivity to get people invested in the project. Airdrops are akin to giveaways, a term that also appears as a top term with 339,904 instances. To accompany both "airdrop" and "giveaway," terms like "win," "edition," "launch," "free," and "list" appear in the second half of the top

forty terms with “win” having the most uses at 155,827 instances and “list” being used the least with 124,866 instances. All these terms relate to both promotional strategies, as airdrops and giveaways were marketed as limited-edition project launches that were listed as free content for investors to win through contests. The term “day” was used in promotional tweets such as “today is the day” as a common announcement message for upcoming airdrops, giveaways, and launches. While many of the terms in this category were related to airdrops and giveaways which provided free NFT assets to investors, there are some financially driven terms also present. Many of the NFT market websites sold NFTs through auctions, which was a term used 150,827 times. Along with the term “auction,” the term “bid” was used 131,466 times. Finally, the terms “buy,” “sale,” “sell,” and “price” are all present in the top forty terms.

In the “peak” period, the terms related to the promotion of NFT projects changed quite a bit in terms of increased volume of use. The terms “airdrop” and “giveaway” are still top terms commonly used with 909,418 and 701,252 instances respectively with “airdrop” being the most used term overall. The related terms of “win,” “launch,” “free,” and “list” are all still included in the top forty terms, however, two new related terms of “enter” and “coming” were used in the “peak” period. Many airdrops and giveaways required people to enter them as contests which were marketed as “coming soon” launches. The term “winners” also appears in the top forty of the “peak” period with 372,372 instances used. The only remaining financially driven terms were “sale” and “price.” The term “OpenSea,” which was one of the largest NFT art marketplaces, is the first instance of a named marketplace website in the top forty terms over all three periods with 166,519 mentions.

During the “crash” period data, terms that relate to the promotion of NFT projects saw a reduction in associated terms. The term “giveaway” was still commonly used; however, the term “airdrop” falls significantly in usage. The terms “free,” “enter,” “win,” “winners,” “coming,” and “price” all remain in the top forty during the collected period. Two new terms, “prize” and “whitelist” appear in the top forty of the collected time period, with whitelist being the most used. Whitelisting was VIP priority access to NFT project launches before they hit the general market. Finally, the term “spots” also appears in the data, which are related to the promotion of projects with limited whitelist spaces or contest entries.

The final category is terms related loosely to the NFT community itself. In the “hype” period, the term “follow” was the third most used word with 371,171 instances. Many creator accounts promoted themselves and their art projects by asking people to follow their accounts to create a community of interested members around their projects. Similarly, the term “share” also appears in the top forty with 142,765 instances used, as creators tweeted out to their networks to share new launches and projects to generate interest by reaching as many people as possible. Another common community building tactic was asking interested parties to join, which was used as a term 207,787 times, other communication methods, like a Discord server, to further create a connected community. “Discord” appears as a common term in the “peak” period, as the communication application became popular for creating communities around certain projects or aspects of the NFT world. The terms “celebrate” and “support,” which were used 141,259 and 126,033 times respectively, were used to foster a positive and supportive community for creators and their projects. Terms like “time,” “check,” “live,” “start,” and “world” also

appear in the top forty terms of the "hype" period. Many of these words are related to community events (usually centred around creators and projects) along with terms that are intended to support their communities to check out new creators and projects.

During the "peak" period, the most used terms in this category changed slightly. The terms "follow" and "join" are still commonly used, with 855,187 and 442,201 instances respectively, and in the top ten of this period. Terms being used by the community to support other creators and projects are still used with the inclusion of "check," "live," "time," "celebrate," "tag," and "world" in the top forty. These terms are the only terms that repeat from the previous period. Both "friends" and "community" are terms that appear in the top forty terms of this period with 247,354 and 219,227 instances used. The remainder of the terms like "team," "future," "hope," "lucky," and "excited" are all very positive terms that would have been directed at the NFT Twitter community.

In the data collected for the "crash" period, there is no distinct change in terms related to the NFT community. The terms "follow," "tag," "friends," "join," "community," "time," "discord," "lucky," and "world" are all the terms remaining from the previous periods. Two additional terms appear during the "crash" period data in "event" and "June," which are related to community events and conversational messages.

Looking now at the topics the community was engaged in through hashtags, figures 4, 5, and 6 show the top forty hashtags used during each period. The top forty hashtags were chosen for consistency with the most used terms, as well as possessing similar trends of rapid decrease in the hashtag usages after the top forty.

Figure 4. Top forty hashtags of the "hype" period

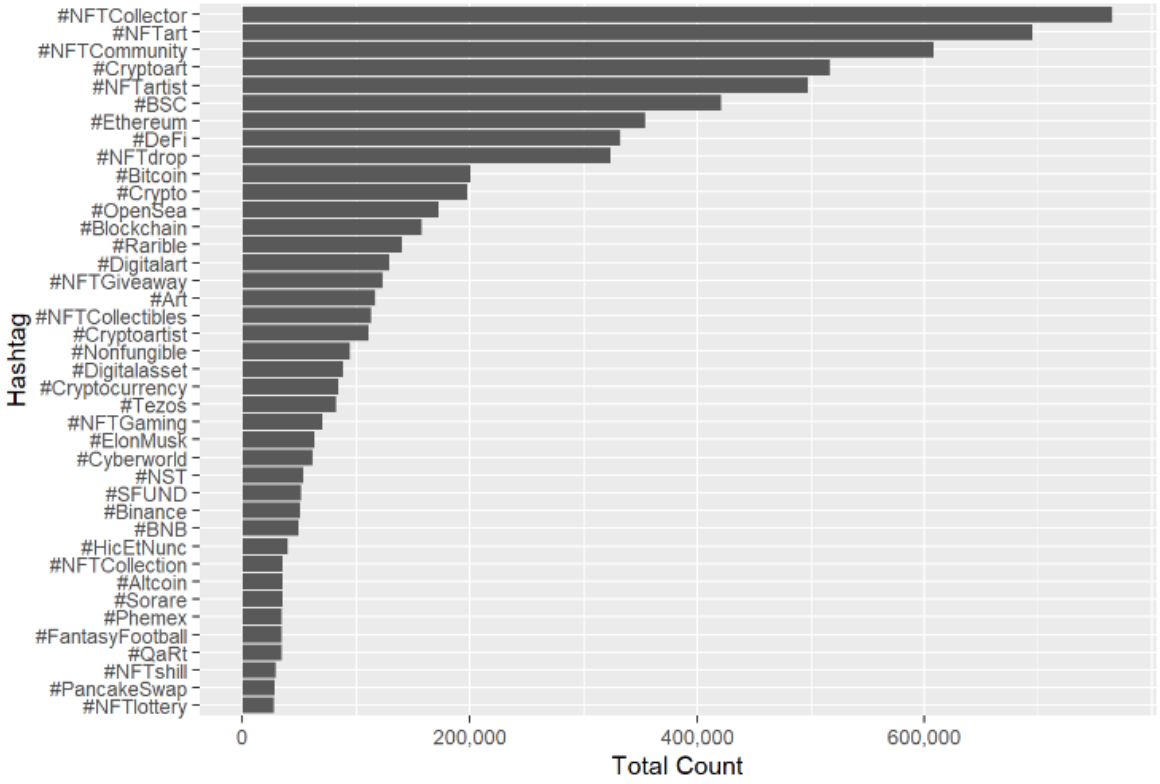


Figure 5. Top forty hashtags of the "peak" period

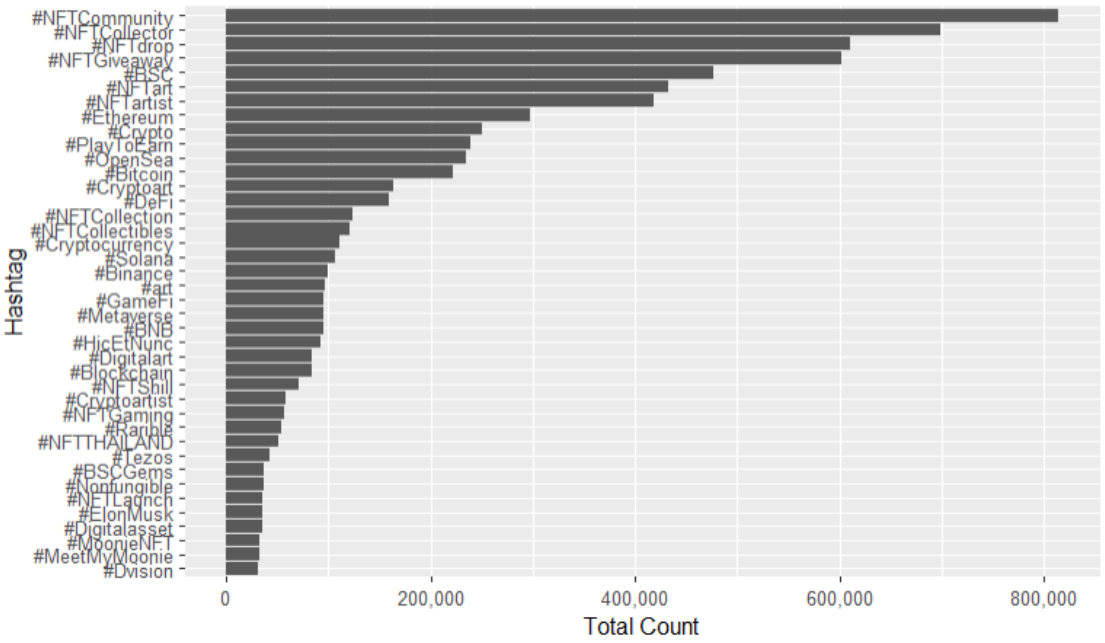
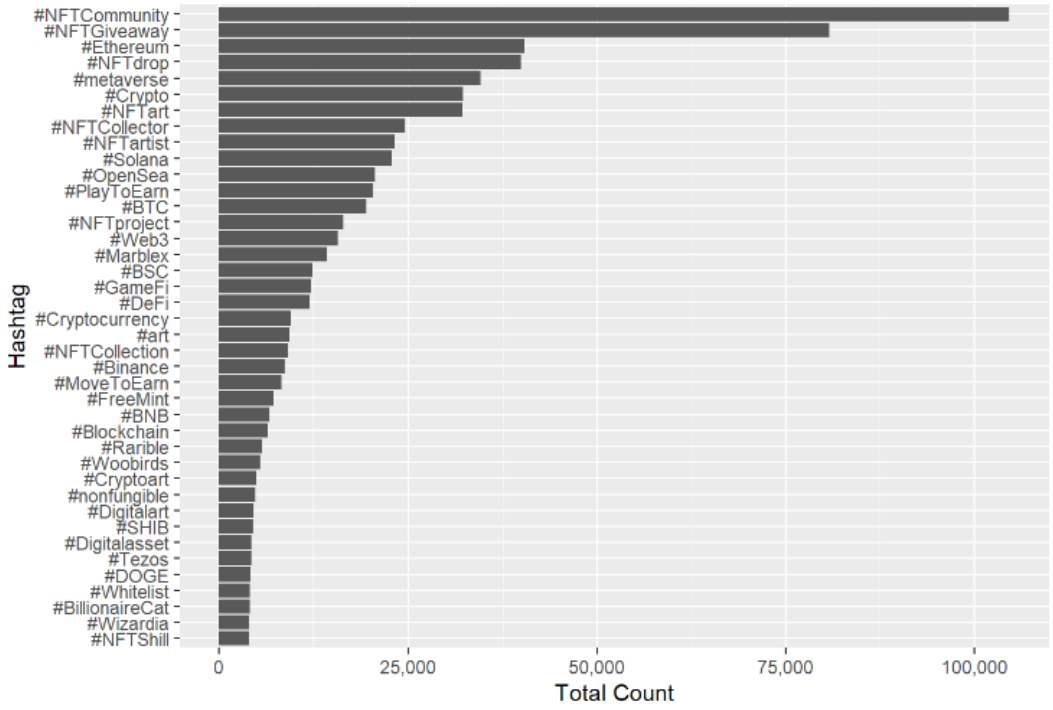


Figure 6. Top forty hashtags of the "crash" period



During the “hype” period, only six of the included hashtags are reflected in the top terms being used by the NFT Twitter community. The most used hashtag was “#NFTCollector,” with 765,328 occurrences, showing a focus on the buyers of the NFT market. The second most common hashtag was “#NFTart” with 695,217 occurrences, making it the most referenced of all NFT creative outputs. The general term “#NFTCommunity” completes the top three most used hashtags with 608,455 instances, which encapsulates the entirety of all creators, buyers, and those engaging with NFTs. The fourth most used hashtag with 516,497 occurrences, “#Cryptoart,” is a more general term that includes NFT art while the fifth most used hashtag directly references NFT artists with 496,862 uses. Crypto artists are noted as a separate creator with the inclusion of “#cryptoartist” which was used 110,893 times. As seen in the most used terms, both “NFTdrop” and “#NFTGiveaway” also appear as commonly used hashtags. The term

NFT collection continued to be commonly used in both outlets of the discourse with its inclusion as a hashtag. The general terms of “art” and “digital art” were commonly used hashtags during this period along with the more specific art-related hashtags. The only specific person to appear in the top forty hashtags is Elon Musk, who was referenced 62,848 times through hashtag use and only two specific projects are mentioned in “Cyber World” and “Pancake Swap” with 61,626 and 27,956 occurrences. Both Cyber World and Pancake Swap are NFT marketplaces that borrow GameFi incentives to attract users.

As the eighth most used hashtag, “#DeFi” was used 332,765 times. Short for decentralized finance, its prevalence is mirrored by the multiple cryptocurrencies and blockchain related hashtags included in the top forty hashtags. Both Binance Smart Chain (BSC), Ethereum, and Bitcoin are in the top ten most used hashtags at 420,904, 354,018, and 200,847 occurrences respectively. “#Crypto,” which was also a commonly used term, is included as a top used hashtag. Other related hashtags of “#nonfungible,” #digitalasset,” “#cryptocurrency,” “#Tezos,” “#NST,” “#SFUND,” “BNB,” and “Altcoin” are all present in the top forty most used hashtags. Numerous NFT art markets and cryptocurrency trading websites appeared as top hashtags during the “hype” period; “#OpenSea,” “#Rarible,” “#HicEtNunc,” “#Binance,” “#Phemex,” and “#QaRt” with OpenSea being the most referenced website 172,286 times. QaRt was referenced the least with 34,435 occurrences. NFT Gaming is also included in the top forty hashtags having been mentioned 69,641 times along with “#FantasyFootball” and the mention of Sorare, which had a fantasy football NFT collectible game available. Finally, the inclusion of “#NFTShill” with 29,205 occurrences is notable considering some of the criticism made against NFTs.

Heading into the “peak” period, many of the hashtags from the “hype” period remained being used by the community but the totals in usages are quite different. “#NFTCommunity” was now the most used hashtag with an increase in use of 814,138 times. The previously most used hashtag of “NFTCollector” decreased in use during the “peak” period, now only being used a total of 699,430 times. The hashtags “#NFTdrop” and “#NFTGiveaway” both increased in total uses significantly. BSC remained the most talked about blockchain application while Ethereum also continued to be the most referred to blockchain. Solana is the only new blockchain application that appears as a hashtag with 106,335 occurrences. The general term “#Crypto” also increased in usage during this period. Both “#NFTart” and “#NFTartist” dropped in usage to 431,912 and 418,352 instances.

The main NFT art market website referenced by the community continued to be “#OpenSea” with 234,934 occurrences used, which was an increase from the “hype” period. Rarible remained as a top forty hashtag but its use decreased significantly to only 53,364 times. A new NFT marketplace, Dvision, appears in the top forty hashtags of the “peak” period with 31,120 occurrences. “#DeFi” continues to be commonly used but saw a significant drop in usage. Bitcoin remained the most referred to specific cryptocurrency with a slight increase in use with no new cryptocurrencies being referenced through hashtags.

The tenth most used hashtag, “#PlayToEarn,” was newly used during this period with a total of 239,381 occurrences. To go along with its inclusion, a hashtag for GameFi also appears in the top forty hashtags used alongside the continuation in use of “#NFTGaming.” Only one specific NFT GameFi project, Moonie NFT, is referred to in

two different hashtags of “#MoonieNFT” and “#MeetMyMoonie,” with 32,313 and 31,862 occurrences respectively. A specific NFT community also appears for the first time in the top forty hashtags with 50,794 occurrences in “#NFTTHAILAND.” Metaverse, which is a term used to describe an immersive, interactive, and fully digital virtual world enabled through the hyperconnectivity of the Internet, is just below the top twenty most used terms with 94,737 instances. Elon Musk continues to be the only specific person referred to, decreasing to 35,709 times mentioned. Finally, “#NFTShill” continued to be used by the community, seeing an increase in use to 71,366 times.

Moving into the “crash” period continues the trend of many of the same hashtags being continually used. In the collected period of data, “#NFTCommunity” continued to be the most used hashtag. Giveaways and airdrops are also still in the top hashtags used, along with “#NFTCollector.” NFT art and crypto art continued to be commonly used hashtags. During the “crash” period, the hashtag “#FreeMint” started to be used by the community. Ethereum was still the most referred to blockchain with the cryptocurrencies “#Bitcoin,” “#Solana,” “#Tezos,” “#BSC”, and “#BNB” all being featured in the top forty. Two new cryptocurrencies appear in the top forty of the collected data, the memecoins of “#SHIB” and “#DOGE.”

OpenSea remained the most referred to NFT art marketplace, with Rarible being included in the top forty as well. Multiple new specific NFT projects and websites appear in this top forty; “#Marblex,” “#Woobirds,” “#BillionaireCat,” and “#Wizardia.” Whitelist appears as a hashtag in this period, which mirrors its first inclusion in the top forty terms of the “crash” period. GameFi continues to be represented a few times in the top forty, with “#GameFi” and “#PlayToEarn” included along with a new related hashtag

of "#MoveToEarn." Metaverse is still a commonly used hashtag and "#Web3" is referenced through hashtags, which was a new version of World Wide Web based on blockchain networks. Finally, "#NFTShill" continued to be used by the NFT Twitter community.

4.2. SENTIMENT AND OPINION WITHIN THE NFT DISCOURSE

Having explored the key topics being discussed in the NFT Twitter community, a look into the sentiments the community possessed about those topics allows for a further understanding of the discussion. To quantify the sentiments of the NFT Twitter community of the data period, sentiment analysis was utilized to determine community opinions and emotions across the collected tweets. Through R and by using the AFINN sentiment lexicon to determine sentiment ratings, table 7 shows a breakdown of the descriptive statistics of each period as a starting overview to explore the community's sentiments.

Table 7. Descriptive statistics for each data period's AFINN sentiment analysis

Period	**Average**	**Variance**	**Median**	**Minimum Value**	**Maximum Value**	**Percentage of Positive Tweets**	**Percentage of Negative Tweets**
Hype	1.50	2.78	2	-5	5	83%	17%
Peak	1.51	3.06	2	-5	5	84%	16%
Crash	1.37	3.07	2	-5	5	83%	17%

The minimum and maximum values are the same across all periods, reflecting the max sentiment score totals a word can possess through the AFINN lexicon, however, this situates the average sentiment rating of the tweets as quite middling. The "hype" period

has an average word sentiment of 1.50, which is the second highest average among the three periods. The “hype” period has the lowest variance, meaning the sentiment values are spread out the least around the average score. In a positive sentiment trajectory, the “peak” period has the highest average word sentiment score of 1.51. The variance increases by 0.28, which is the highest increase between the periods. The “crash” period continues increasing in variance by 0.01, meaning the sentiments of the words being used by the community stayed consistent spread out around the average score. There is a drop in positive sentiment, especially when compared to the “peak” period just before it. The “crash” period drops 0.15 to the lowest sentiment word score of the three periods to 1.37.

These descriptive statistics provide an overview to begin exploring the attitudes and opinions around NFTs and how those attitudes of the NFT Twitter community may have changed over time. By looking more in-depth into the tweets of each data period and exploring the sentiment throughout, additional contexts can be investigated around the community and the topics they are discussing. The three data periods can then be compared to each other to determine what opinions were maintained and which shifted over the chosen periods of time. The top and bottom forty tweets from each period were originally chosen to analyze, however, many of the tweets were repeated retweets. To create a more focused analysis, the top ten most positive and the bottom ten most negative tweets were chosen using the AFINN lexicon. Table 8 displays the ten most positive tweets of the “hype” period.

Table 8. Most positive tweets of the "hype" period

Tweet_id	Text	Sentiment
5498690	The selling is amazing but what has been on my mind is breaking ground for diverse mediums winning in #nft. I love the 3D works I see win but I am excited to see culture win. People win. Poetry win. Performance win. Photography win. Film win.	42
3746801	Good morning 🌞 good night Good crypto currency and good luck for all people to get the airdrop Good morning 🌞 good night Good crypto currency and good luck for all people to get the Good morning 🌞 good night Good 😀😊😀😊😀😊 #CyberWorld #NFT #Aridrop	39
4340034	😘Great and Thanks for shared this wonderful opportunity. Best wishes for all. ❤️ I hope that I win this. 🙏 Awesome giveaway. 🎊 🎉Really great. 👍 Always we support you. 👍 Thanks. 🙏 @Ranjank79633672 @Trickysharmajii $QLP #QLIP #NFT #BINANCESMARTCHAIN #AFRICANART	33
2275046	@ICOAnnouncement Great project 🔥 This is a great and excellent project and also the reward is great. Thanks for shared this wonderful opportunity. Best wishes for all team members. Keep going and get to the success #Grandle #Grand #Defi #NFT	32
2664149	@Punk_Network Amazing project.. I think Project Future is very Bright. Great super awesome project. I hope to bring rewards and success to each other, This is a great opportunity for loyal supporters. Thank you. @kuleczka28 @Piotr02214492 @aga_z #PunkNetwork, #NFT & #Polkadot	32
4416985	#Permission #WhoFramedASK #Rarible #NFT Thanks for shared this wonderful Projects. Best wishes for all team Awesome giveaway Project Soon is moon 🚀 Strong and Awesome project. I hope any lucky user can win this Always we support you @MastiLoot @Trickysharmajii @trickyboy555	32
121988	@BilakeFinance Great project #BilakeFinance #NFT I hope it is one of the great project in the world 😍 ❤️ 👍 @Keyamoni555 @xtinagayton Thanks for me big opportunity. Good Luck & All Tasks Done & hope to win this giveaway 👍 ❤️ 😍 Good Luck everyone ❤️ 👍 😍	31

Tweet_id	Text	Sentiment
177853	cryptomonKeys won some @WAX_io #NFT Awards 😍 🥇 Platinum Award: Best Community 🥇 Platinum Award: Most Creative 🥈 Gold Award: Best Art 🥈 Gold Award: Most promising in 2021 Thanks everyone for your support, we're so humbled!	30
1296877	I just won “Liquid Love” from @Robin_Graphics and i LOVE it. I love the colours. I love the movement. I love the way it makes me feel when I look at it. What can I say? Im in love ❤️ Big thanks to @Robin_Graphics , an incredible talent! #love #nft #art #thankyou #beautiful	30
1805376	Thanks for following me @ParisHilton😚 its nice to meet u here&to see how u support this movement!I wish u a very good luck in #NFT space 🍀 #NFTCommunity is super supportive& full of love 💕 you will love it for sure!Hug🤗 Ps.Guys,lets say hello to our new member&show some love🖤	30

All except two of the tweets were related to NFT art and art projects. Tweet 5498690, which is the most positive tweet with a sentiment rating of 42, praises NFTs for enabling a diverse visual culture. The tweet highlights artists as “winning” with the adoption of NFTs and the attributes that this new digital art market supports. It also puts emphasis on the inclusion of artistic media that were normally underrepresented in previous digital art markets, like poetry and performance, listed alongside more common digitally sold art like photography and film. Tweet 1805376 is tweeting at Paris Hilton, welcoming her to the NFT community and thanking her for her support. Using her celebrity influencer status, Paris Hilton did late night talk show segments and media releases to draw attention to the NFT space as well as launching her own NFT project.

The other eight tweets all directly refer to and advertise NFT projects. With Twitter established as a main platform for buying and selling art projects, the prevalence of advertisement tweets is an unsurprising result. Tweet 3476801 is a string of phrases

with the word “good” in it with various subjects. The main context of the tweet is in the reference to an airdrop as it wishes people good luck. Similarly, tweet 2664149 is promoting a NFT art project on the Punk Network, which was a brand focused on art and gaming assets. Tweet 4340034 was posted as entrant requirements into a NFT giveaway for a project launched on QLIP. The tweets feature well wishes with support for the project and website while promoting both parties. Tweet 121988 similarly is responding to a NFT airdrop to get added to the giveaway contest. Tweet 177853 advertises the NFT project cryptomonKeys, which is a NFT meme game, through community accolades and tweet 1296877 advertises an artist through a @ mention and discussing the artwork they received from them.

In the only non-art related tweet, tweet 2275046 is tweeting at ICOAnnouncement, which was one of the largest cryptocurrency platforms (ICOAnnouncement, 2023), thanking them for their promotion of a DeFi decentralized application (dApp) called Grandle. The tweet draws attention to the dApp, wishing it, its teams, and its users’ success in the project. Tweet 4416985 is another tweet in support of a different project, Project Soon, and is also wishing the project and creators involved good luck.

Keeping in mind that the average sentiment rating for the “peak” period increased, table 9 shows the most positive tweets from the period.

Table 9. Most positive tweets of the "peak" period.

Tweet_id	Text	Sentiment
11255915	miracle miracle miracle miracle miracle miracle miracle miracle miracle miracle miracle miracle miracle miracle miracle miracle miracle miracle 🙏 #cryptoart #nft #NFTs #nftart #nftcollectors #NFTCommunity #nftcollector	80
12688447	How do you fancy buying a #GormlessGuy today? 100 to choose from, all just 0.01ETH (gas free) and by buying them, you help them to get back to their mothership! It's a win, win, win, win! You win, I win, they win, EVERYONE WINS! Pls RT! #nft #NFTCommunity	35
5514703	This is great project and good opportunity for all we are glad to have this amazing chance to join it and it is having good support team I wish them all good luck for this awesome project #BSC #NFT #FUB @narendramali922 @Praveen32875904 @Ronak86480279	34
6563665	Thank you for this wonderful opportunity Super amazing project..!! I really do hope this project brings about a great success. This is a great opportunity for loyal supporters. @ampoerhsya @umar_fitriyanti @EvascoKristel @1972Fajar #nft #bsc #marvel	34
12176489	Good Luck today #NFTCommunity! The character “福” (fú) means "fortune" or "good luck.” The concept of good luck is intense in Chinese culture. To surround oneself with lucky charms is to insure luck in life. Please retweet & share the Good Luck! #NFT #NFTlaunch #nftcollector	33
6560107	@Defi_Eagle @SolvProtocol Nice the @SolvProtocol introducing a great good delivering articles on the new job let's supportingly this platform #NFT ERC great good platforms and bringing more info a great good benefits of the best things to everyone and great good sharing your information and many more work	32
6322185	Good my beautiful people. How was your night I hope everyone had a great night. And i i wish everyone wonderful day much love to all. Spread love give love .#love #NFTCommunity #NFT #love #rarible #twitter	31
7318663	Hey $XLM fans, how would you like to win 100 #XLM? Like, follow, and retweet for a chance to win! Winner will be chosen after 1pm EST tomorrow. Want an extra entry? Tag friends in the comments for up to three additional chances to win. Good luck! #Stellar #NFT #FreeCrypto	31

Tweet_id	Text	Sentiment
7899430	@BabylonsNFT @srn_art To be honest, I really admire the beautiful of this NFT. It's really a wonderful masterpiece, I support all of your artworks. Thanks for this good opportunity, good luck to all of you guys. @dwi_esteban @lukamendra @stefanusae99 #BabylonsRising #srnArtGallery #BSC #LLAMA #NFT	31
5937783	@ShaunWitriol @Reporternaut Ftxfund has the best potential to help us achieve the best possible success and good luck to the team Nice project and good team efforts to reach the top and having great experience with the most stronger project I have ever seen #FTXFUND #NFT #FTFX #Defi @ElonMusk @cz_binance	30

Eight of the top tweets in this period are promoting NFT projects. The most positive tweet with a sentiment rating of 80 features the word “miracle” repeated along with some of the most used hashtags by the NFT Twitter community. The accompanying hashtags, however, are too general to add much context to what the tweet is specifically referring to. Tweet 6322185 is the second of the tweets that do not relate to art projects, instead tweeting in general to the NFT community wishing them love and wellbeing.

Besides these two tweets, the remainder of the top ten are all clearly promoting specific projects. The second most positive tweet refers to the community as “winning,” which is reminiscent of the top positive tweet from the “hype” period. The context of this tweet, however, is quite different. Instead of praising NFTs being a win for the creative community through a diverse art market fostered by NFTs, this tweet focusses on linking the winning of the community to the investing in a particular art project. The next tweets of 5514703 and 6563665 are similar tweets with only minimal changes in phrases or terms, however, they all utilize different hashtags. Tweets 5514703 and 6563665 both mention “#BSC” but then refer to different projects in “#FUB” and “#marvel” respectively. Tweet 12176489 does not explicitly mention the project it is promoting but

wishes the NFT community good luck in a project launch. Tweet 7899430 also promotes a NFT project, Babylons NFT, through praising the creators and artwork. In the two non-art related project tweets, tweet 5937783 mentions the project FTXFUND, which ended up being one of the largest cryptocurrency exchange sites. The tweet also mentions both Elon Musk and CZ, who is the CEO and co-founder of Binance. Each of these tweets mention the positivity of opportunities, amazing projects, and success for those involved in those projects. Tweet 7318663 does similar promotion to the NFT art projects of wishing the community good luck but instead of promoting a project, is promoting the giving away of cryptocurrency through a contest.

Heading into the "crash" period with its decreasing average sentiment score, the top total sentiment scores are considerably lower than the top tweets from the previous periods. Table 10 shows the top positive tweets of the "crash" period.

Table 10. Most positive tweets of the "crash" period

Tweet_id	Text	Sentiment
8858654	LUCK❤️ LUCK❤️LUCK❤️ LUCK❤️LUCK❤️ LUCK❤️LUCK❤️ LUCK❤️LUCK❤️ LUCK❤️LUCK❤️ #nftart #NFT #NFTs #nftartis #NFTCollection #NFTCommmunity #NFTCommunity #nftcollector	36
8496986	@MARBLEXofficial This is a great and excellent project and also the reward is great. Thanks for shared this wonderful opportunity. Best wishes for all team members. Keep going and get to the success. #Marblex #consensus2022 #MBX #klaytn #nft #crypto #Blockchain #blockchaingame	26
8470133	Thanks For This Great Opportunity I Would Like To Thank All Of You For This Lovely Project I Love It Its Looks Like Best And It Will Be Best Information Airdrop: @asam184 @asghar0051 @trxhumayun @toancryptobg #Metaverse #nft #EliteMeta #Airdrop	25

Tweet_id	Text	Sentiment
8659323	@PatronDoge Wow fantastic project has an outstanding team that really helps bring the best out of a project. I hope this project will gain success in near future.#PatronDoge #PatronDogeDAF #PATRON #Meme #Memes #NFT #PatronArt	24
8993714	BONUS #Giveaway Next 200 mints will enter a raffle to win @SpaceRiders_NFT So 0.01 Mint, a chance to win an NFT and be entered to win the 2eth prize 🚀 1 x Winner space rider 3 x Winner Access Pass 1️⃣ Like & RT 2️⃣ Comment done and Token ID minted to enter #NFT #NFTdrops	24
9049190	Good morning, good afternoon, good evening and happy Saturday #nft fam! Hope y'all have a wonderful weekend. Get out there, enjoy the fresh air and do something that brings you happiness 🐶	24
8660757	@CryptosGemsCom WIN 2 X FREE HODL HAND NFTs An AMA with HODL Simply join the HODL Discord group today by 6pm UTC for a chance to win your own HODL Hand #NFT you get a chance to win this HODL hand simply by joining the AMA Join now and be in for a chance of winning https://t.co/Iv6aS88Tbi	23
8557393	🎉 Our First WL Giveaway + ($40) NFT 🎁 ❗ 30 lucky peas will win WL & 1 super lucky pea will win a pea for free! To Enter: - Follow @pea_pets - Like & RT - Tag frens who would like a pet pea 💚 ⏰ 24 Hours #PeaPets #NFTCommunity #NFTs #NFTGiveaway #NFT #NFTGiveaways #Giveaway	22
8605887	Wanna win this @GrouchyTigers #NFT? Simply reach Level 5 in our discord and be entered to win 🎉 Want more chances to win? Simply reach Level 10 in our discord and get 2 entries to win 🎉 Join us 👇 Winner will be announced Thurs June 16th @9pm EST	22
8732983	This is a amazing project. It's a very nice or strong project. The project management is awesome. I'm impressed. Best of luck @MdFahadSani1 @shuvo20012 @NaimHossin086 #NFT #roleclub	22

The most positive tweet of the crash period, tweet 8858654, features the word "luck" repeated with the heart emoji and accompanied by commonly used hashtags, which do not add much context to the specific intention of the tweet. Tweet 9049190 also

does not reference any project, instead tweeting at the NFT Twitter community in general well wishes in a positive message, referring to the “nft fam.”

The second most positive tweet is showing support for the GameFi website Marblex and a new gaming project the website announced; Consensus 2022 was a cryptocurrency industry conference with Klaytn being an open source blockchain (Klaytn, 2023). Five of the top 10 most positive tweets are promoting NFT project airdrops. Tweet 8470133 is promoting a metaverse project, EliteMeta. Both tweets 8993714 and 8557393 are advertising NFT art airdrops while tweet 8660757 is advertising a creator Ask Me Anything (AMA) to promote a giveaway. Tweet 8605887 is using a NFT giveaway to encourage people to join the projects Discord and become an active, contributing member to the Discord server. Tweets 8732983 and 8659323 are also promoting and wishing success to two projects, one of which is a Meme art NFT, but do not indicate any clear airdrop or giveaway contexts.

Now shifting focus to the other end of the sentiment analysis scale, table 11 shows the most negative tweets from the “hype” period. The most negative tweets feature slightly different topics but some still remain to be promotional in nature.

Table 11. Most negative tweets of the "hype" period.

Tweet_id	**Text**	**Sentiment**
3284918	Don’t you fucking dare. We need more #Basquiat not less. I fucking can’t with this #NFT garbage ass bullshit and I swear to the pharaohs you burn his drawing you’ll regret it forever.	-20
1509037	Punpun lost in yourself Punpun lost in Punpun lost in yourself Punpun lost in yourself Punpun lost in yourself Punpun l... #Tezos #NFT $xtz	-21

Tweet_id	Text	Sentiment
1741619	IF YOU CAN'T BUY MY SHIT, RT MY SHIT, FOLLOW MY SHIT, LIKE MY SHIT, SHIT, I NEVER FORGET THAT SHIT. PEACE ✌️ 🧿 . #nftcollector #art #NFTartist #artcollector #opensea #ownart #NFTCommunity #digitalart #NFTcollectibles #nft #memeart #memeartishighart #4JED	-21
2697036	#37917: Low Fi Green Loss Bastard by #tz1gF8itfTHov8Ny5R3TMzXwn5F15maoCJz5 Low Fi Green Loss Bastard by Mad Monk. Minted April 2021 on hic et nunc. Inspired by Bastard Gan Punks. #Tezos #NFT $xtz	-22
667165	“No im not a shit coiner, i’m just using #NFT’s to make more #Bitcoin” “No im not a shit coiner, i’m just using #XRP to make more #Bitcoin” “No im not a shit coiner, i’m just using #ETH to make more #Bitcoin” Different 3 letters, same shit. You’re a shit coiner. 💩	-23
2910691	TWAT OF THE DAY.... This #twat clearly is a dick head and has no #respect due to their poor #parking what a useless prick #norespect #poorparking #muppet #nft #standards	-23
3358487	Whoever thought it was cool to take 15 to 17 pieces of art, only to flip it when I was giving this away for free, is one fuck boi ass piece of shit. Like who the fuck?! Please expose yourself so I can shit on your whole existence you selfish piece of shit. #NFT #NFTCommunity	-23
3527428	#58246: Infinite Fucks by fuck fuck fuck fuck fuck fuck fuck dylan murphy | pretty bad | pretty bad co #Tezos #NFT $xtz	-32
4901744	BUY A DICK BUY A DICK BUY A DICK BUY A DICK BUY A DICK BUY A BUY A DICK BUY A DICK BUY A DICK BUY A DICK ... #nft #nfts #nftart #cryptocurrency #art #dick	-40
3380751	#54434: Fuckitty by FUCK FUCK FUCK FUCK FUCKITTY FUCK FUCK FUCK FUCK FUCK FUCK FUCK FUCK FUCK FUCK FUCK FUCK FUCK FUCK FUCK FUCK FUCK FUCK FUCK FUCK FUCK #Tezos #NFT $xtz	-96

The most negative tweet of this period, with a sentiment rating of -96, does not have any discernible context behind its textual context. The tweet simply features the word “fuck” with hashtags of “#nft” and “#Tezos,” which is a blockchain network that specializes in peer-to-peer transactions (Tezos, 2023) with its own cryptocurrency called Tez ($XTZ). Tweet 3527428 follows a similar theme of being composed of expletives

with the same accompanying hashtags. Looking at the historical financial data from CoinDesk.com for the period of January 1 to May 31, 2021, the value of XTZ was incredibly volatile with sharp highs and lows, adding potential context to these two tweets. Tweet 3527428 also references "pretty bad co.," which was an artistic brand that created and sold Tezos-based NFTs. Tweet 1509037 also appears to be referencing a NFT project on Tezos, however, there is little accompanying context to the exact intentions of this tweet.

Tweet 2910691 also has vague context, possessing some strong anger directed at someone else. There is a NFT-based car game, called Parking Infinity, that this tweet may be referring to but there is no discernible confirmation to this. Tweet 4901744 embodies one of the subsets of NFT art, which is embedded in Internet meme culture. Internet meme art spans a wide variety of themes and content, which included some artists diving into more lewd and vulgar themes. The tweet here is promoting a project that consisted of stylized art of genitalia. Meme art became a huge portion of the NFT art market, a direct counter art culture to the more traditional art forms, seen in projects such as the Bored Ape Yacht Club, to become some of the most expensive and recognizable NFT art collections.

Some of the most negative tweets are not actually negative in intention, outlining a main limitation of sentiment analysis and its inability to discern context. Tweet 1741619 use expletives to promote the poster's art, who is jokingly referring to their art as "shit." The intended NFT meme art audience was far more likely to market and respond to messages that resembled this type of more rude and vulgar language and self-deprecating comments. Tweet 2697036 has little negativity as well and is promoting a

NFT art project, with its negative sentiment being assigned to the title of and inspiration for the art project that possess words like “low,” “loss,” and “bastard.”

Lastly, tweets 3284918, 667165, and 3358487 echo some of the main critiques that NFTs have come under fire for; scams, frauds, bad actors, and the overall feeling of the NFT market as being a waste of crypto investment. Tweet 667165 references the term “shit coin,” which was the term given to a cryptocurrency with little to no value and seen as having no real purpose, and “shit coiner,” who was someone that invested in those cryptocurrencies. The user here is relating NFTs, and many of the main cryptocurrencies that were used to buy and sell NFTs, as being “shit coins” over one of the more long-standing cryptocurrencies of Bitcoin while putting down those who are investing in NFTs and other cryptocurrencies. Tweet 3358487 states that the art in question was given away for free, which is an example of a user who was out to make quick financial games by playing the system. While the seller did not necessarily claim the art as theirs, the art was still obtained and sold under questionable dealings unintended by the original artist. This tweet shows the lack of detection and enforcement over stolen art which needed to be done by community policing. Tweet 3284918 portrays a common public opinion of NFT art being “garbage art” compared to more traditional modes of art, referenced by the mention of Basquiat, a neo-expressionist artist.

Moving on to the most negative tweets of the “peak” period, many of the same characteristics continued to be present in these ten tweets which are displayed in table 12.

Table 12. Most negative tweets of the "peak" period

Tweet_id	Text	Sentiment
13091511	['_____ We are our thoughts; a mind cannot be imprisoned, nor can it be destroyed. A body can be tortured and destroyed. A body cannot be imprisoned without destroying its prison, it cannot be #tezos #hicetnunc #NFT']	-19
554790	Look what I found! Fuck You! You Fucking Fuck! collectible? #rarible #ethereum #nonfungible #digitalasset #nft via @rariblecom #fuckyou #fucking #fuck	-20
11013072	OH FUCK! MORE MINTS! Fuck Yous #1730, Fuck Yous #1729, Fuck Yous #1728!!! KILLER FUCKING SET!!! Mint yours at #NFT #NFTCommmunity #FU	-20
13308440	@CryptoCryptid2 lolol who the fuck wants an #nft of an ugly bitch with hairy ass eyebrows? The real bad bitch crypto feminists are sexy, smart, and know it. They are 🔥.	-20
11770034	#NFT- not fucking today #NFT-no fucking time #NFT- now fucking tired #NFT - New Fucking Trend #NFT- new to Fucking Town #NFT -now follow this #NFT - new featured talent #NFT -need funds today #NFTLAUNCH #nftart #NFTCommunity #NFTdrop	-23
7277952	Feel the fury closing in All resistance wearing thin Nowhere to run from all of this havoc Nowhere to hide From all of this madness, madness, madness Madness, madness, madness [Ruelle - Madness] #nft #nftcollector	-24
7521215	I hope people get more into the habit of calling out frauds/fakes, bullshit artists/cons, influencers/liars, thieves/rugpullers/honeypotters, scam artists, bad actors, performative people, shitty #defi & #nft projects, loose smart contracts & roadmaps w intentional misinformation	-24
11038206	BITCH IM UNDER...WORLD... TILL I DIE!... TILL I DIE... SOOUULLL REAPER... TILL I DIE... TILL I DIE... WE DEM BONE THUGZ TILL I DIE.... TILL I DIE... IN UNDERWORLD IM GOOD TILL I DIE... #whatistheportal TILL I DIE... @machinegunkelly #nft #nfts #solana #SolanaSummer #solananfts	-26
12884860	FIRE EMOJI FIRE EMOJI FIRE EMOJI FIRE EMOJI FIRE EMOJI FIRE EMOJI FIRE EMOJI FIRE EMOJI FIRE EMOJI FIRE EMOJI FIRE EMOJI FIRE EMOJI FIRE EMOJI FIRE EMOJI FIRE EMOJI FIRE EMOJI $FTM #NFT #NFTs	-28

Tweet_id	Text	Sentiment
7835601	WHAT DA FUCK is wrong with these MOTHERFUCKERS selling fucking RUG PUNKS for fucking 0.0075 Ξ and selling their fucking PHYSICAL RUG ORDER PASSES for fucking 0.075 Ξ rn? GET THE FUCK outta here FUCKING FUCKS! @rug_wtf #RugPunks #NFT This tweet is presented to you by RETARDED™	-32

The most negative tweet, with a -32 sentiment rating, features text content that comments on the valuing of owned NFT assets in a crude, angry way. RugPunks was an art project available on OpenSea, which used Ether for its cryptocurrency transactions. Referring to CoinDesk.com's historical financial data, Ether (ETH) was quite volatile during this period between May and October 2021. ETH spent some of this time in the red, especially during the summer months, falling to lows in price. The tweet mentions the value of ETH and knowing the state of the cryptocurrency's valuation along with the tweet's overall vitriol, potentially adds extra context to understand the negativity of the user.

In another example of the limitations of sentiment analysis through contextual understanding, tweet 12884860 is miscategorized. The tweet is most likely remarking excitedly about the increasing value of assets, which would be positive for the user. The AFINN lexicon associated the word "fire" with negative sentiments, however, in the context of the phrase "fire emoji," it has positive connotations. In this tweet, the phrase "fire emoji" is used alongside mentioning $FTM, a cryptocurrency called Fantom, most likely connecting to the value of FTM around this time. Again, referring to the historical financial data, FTM started to become stronger during this period, after a weaker financial period. There are also some miscategorized promotional tweets in this top ten. Tweet 11770034 is promoting a new NFT launch and featured artist, using expletives to

create a play of words using the abbreviation of “NFT.” Tweets 554790 and 11013072 both use expletives while advertising NFT art, while tweet 11013072 also promotes others to use the same website to mint work of their own. Tweets 13091511 and 7277952 are using dramatic words that have negative connotations to thematically promote NFT art projects. Tweet 11038206 is in promotion of a project that was launched and endorsed by the celebrity Machine Gun Kelly. In a similar trend, this tweet possesses words that normally have negative connotations; however, the context is once again misconstrued by the sentiment analysis lexicon.

Finally, tweets 13308440 and 7521215 have different content compared to the rest of the most negative tweets of this period. Tweet 13308440 is tweeting at a user and insulting either the user or their art, showing a stark contrast to the more supportive community contents of the most positive tweets. Tweet 7521215 specifically refers to multiple issues that NFT critics consistently mentioned in their discourse as to why NFTs will not live up to expectations and will eventually fail. The tweets mention art fraud, art theft, malicious users, scams, dubious DeFi applications, and questionable business practices. All of these were major issues that plagued the NFT and cryptocurrency markets and these tweets are calling out for the community to be more willing to denounce the bad actors that are causing these issues.

The most negative tweets from the “crash” period data continue to show many of the same trends as the previous periods, shown in table 13.

Table 13. Most negative tweets of the "crash" period

Tweet_id	Text	Sentiment
8516596	RT @OongaNFT: We are 8,999 Oongas. Launching tonight. 🐹 First 2600 FREE 🐹 Rest is .006 ETH Go fuck you, you fucking fucker fat fucking fuck…	-19
9087813	Fuck you fake roadmap Fuck you slow rug Fuck you be patient Fuck you "we are building a worldwide brand" #nft #freemint	-19
9193452	#MyFuckingEgg 🥚 + staking $SPAWN coming 19th June! First 4.000 Free mint 2x per wallet 🔥 then 0.005 #ETH 👊 🚫 No fucking whitelist! 🚫 No fucking roadmap! 🚫 No fucking clone art! Let's fucking join our discord #FreeMint #NFTGiveaways #NFTs #NFT	-19
8595868	Yeah thanks #Twitter. I was totally pushing someone to die by telling an non-sentient corperate entity made up of a bunch of scam artist swindling people out of money with this #NFT crypto bullshit to go fuck themselves. You are just making shit worse as always.	-20
8676092	If I read another white paper with a ass #swap, market place, some dumb ass #NFT, & donating to a charity while having above 6% tax, DAO this & #DAO that!!!!! I'm going to lose my shit! Please #devs .... build some shit worth investing in! Is that too much to fucking ask?	-20
9117713	Fuck it $3, I'll do this shit but bet your ass I'm using a side wallet for this shit though. If it's get drained it's got some scammy NFTs and some weird coins that showed up one day. #SolanaNFT #NFT #Rugme @topfeeder668 this shits right up your ally!	-20
9258371	⚠️ 2013 - You missed BTC ⚠️ 2014−YoumissedDOGE ⚠️ 2015 - You missed XRP ⚠️ 2016−YoumissedETH ⚠️ 2017 - You missed ADA ⚠️ 2018−YoumissedBNB ⚠️ 2019 - You missed LINK ⚠️ 2020−YoumissedDOT ⚠️ 2021 - You missed $SHIB ✅ In 2022, don't miss _____. #crypto #nft	-20
8669649	JUST SHIT @ApeJustShit Team - Don't bother, they are shit. Roadmap - Nope they're all shit. Art - It's literally shit. Mint Price - Worth a piece of shit. Free Mint. Chain - ETH, where all the shit is. #Degenmint #NFT #FreeMint #NFTLaunch #freemintNFT #NFTGiveaway	-23
8653530	Srsly... WTF Did I buy? WTF is this? WTF am I? Whats happening? @WTF_Did_I_buy? #wtfdidibuy? WTF? WTF? WTF? #FreeMint #NFT #freemintNFT #NFTs #NFTdrop #NFTCommunity #NFTProjects	-24

Tweet_id	Text	Sentiment
8973999	FUCK OFF FUCK #nft	-124

In the most negative tweet of the entire dataset, with a sentiment score of -124, the phrase "fuck off" is featured in all caps along with the hashtag "#nft" with no other context. The context of tweet 9087813 is also unclear; the tweet is calling out various negative attributes of NFTs like fake roadmaps and slow rugs while mentioning a general worldwide brand in distaste. However, the included hashtags do not offer much additional context.

Tweet 8669649 has many negatively associated words while also reacting in perceived anger towards the project ApeJustShit. The tweet, however, is another example of the AFINN lexicon not being able to read context behind the advertisement of another meme NFT art project. The accompanying hashtags in the tweet, like "#NFTGiveaways," "#NFTLaunch," and "#NFTdrop," add additional promotional context to the tweet. The Ape Just Shit project was from a creator of pixel art collections that marketed themselves as "[shitting] on basic degen free mint projects without a crap" (Ape Just Shit, 2023); the overall tone of the project and creator are reflected in this promotional tweet which were intended for specific buying audiences of those interested in NFT meme art.

Tweet 8653530 has similar context issues for the AFINN lexicon. At first glance, the tweet possesses quite negative words and potentially linked to the crashing value of the market; the tweet seems confused about what was just purchased and why something

bad seems to be happening. The accompanying hashtags like "#FreeMint" and "#NFTdrop" shift the context back to promotional. The crudeness of the tweet also matches the aesthetic and tone of the project's creator and the potential intended buyer audience. This is additionally seen in tweets 8516596 and 919352, which features crude language along with promoting a NFT project through a giveaway. Tweet 8516596 mentions the project Oonga, which featured art of cartoon gerbils and the creator used common meme phrases in their Twitter posts. Tweet 919352 promotes the project My Fucking Egg, whose creator targeted the NFT meme art audience with more vulgar language and aggressive promotion.

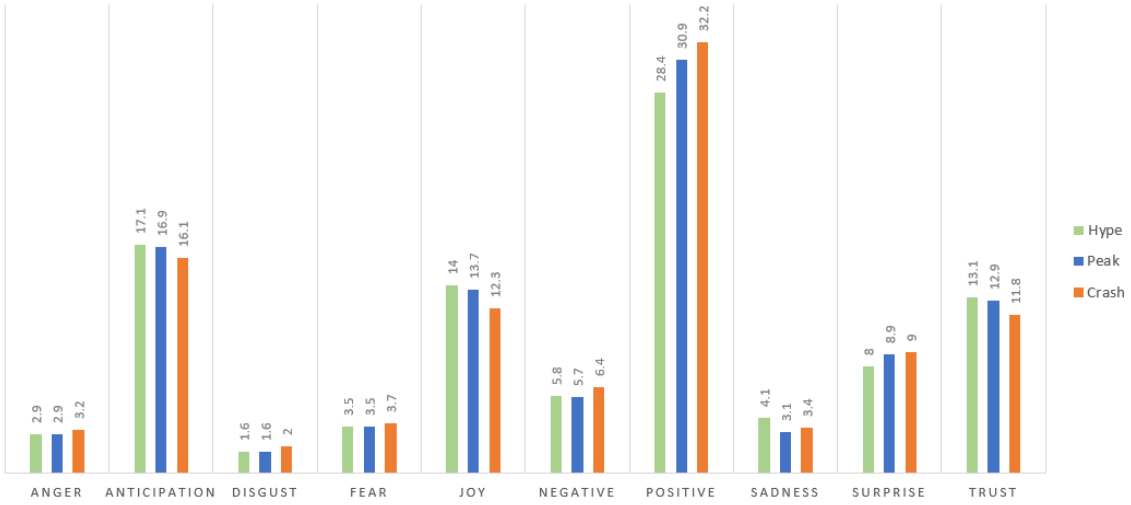
Both tweets 8676092 and 9117713 feature some of the main issues seen in NFTs. Tweet 8676092 is challenging the NFT scammers by investing in their projects to prove a point using a side cryptowallet. Tweet 8676092 mentions white papers, which are informational reports about a certain topic, and the users revolt over how some projects and organizations have been donating cryptocurrencies made through NFTs to potentially get around taxes. The tweet implies this is ruining the valuation of the market and wants something better to invest in.

Tweet 8595868 stands out from the rest of the most negative tweets, as it seems that the user was either banned or warned about using abusive language toward another user. The tweet mentions the user as having called out a corporation that was shilling and scamming people with NFTs and was flagged due to inappropriate and suggestive phrases.

With the large number of tweets collected, it is impossible to analyze each individual sentiment rating score. Having looked at the topmost positive and bottommost

negative tweets of each period, a sense of both extremes of the sentiment scale was explored through assigned sentiment score values. Turning now to using the NRC lexicon, the emotions behind some of the individual words being used can begin filling in the missing middle gap remaining. As mentioned, the NRC lexicon assigns and sorts certain words into one of eight different emotions and two categories of positive or negative. Figure 7 displays the percentage of associated words of each category across the three periods using the NRC lexicon.

Figure 7. Average NRC emotion sentiments in each period



Overall, the emotion of words in the collected tweets were overwhelmingly positive over each period. The trajectory of the positively associated words increased from the "hype" period into the "peak" period with 28.4% and 30.9% of the total associated words respectively. The increase in this category is also the largest increase between any of the periods and sentiments. Surprisingly, even with the lower amount of data collected, the average of positively associated words rose in the "crash" period. The next highest percentage is seen in the specific emotion of anticipation. Anticipation

started with the second highest percentage overall in the “hype” period with a 17.1% but, unlike with the positive category, had a small decrease of usage in the “peak” period. The “crash” period continued to decrease with the small sample of data collected but not significantly, meaning there is a chance it stayed quite consistent overall. Joy and trust are quite close in percentages and consistently decrease over time. The last positive emotion of surprise has the lowest percentage total of the positive grouping but features a very slight increase between the periods, the only other positive emotion to increase besides positively associated words.

Surprisingly, the average usage of negative emotion words was quite low over the entire period. Words associated with the negative category were the most common of this grouping, staying consistent in usage over the “hype” and “peak” periods with a 5.8% and 5.7% respectively, with a larger increase in the small sample of data collected during the “crash” period. Sadness was the next most associated negative emotion in the “hype” period with a decrease of use into the “peak” period. The emotion of fear and anger also remained quite consistently used over time with little variation, with small increases in the data collected during the “crash” period. The least most associated emotion over the entire period was disgust, which remained consistent over the “hype” and “peak” periods with a 1.6%, while also having a slight increase in the collected sample of “crash” data.

Taking the two NRC categories of positive and negative for a more detailed look into some of the discourse associated with certain emotions, the top forty words in each category can add to the understanding of opinion in the discourse. Figures 8, 9, and 10 show the forty most used words that are associated with the positive category during each period.

Figure 8. Top forty words associated with the positive NRC association in the "hype" period

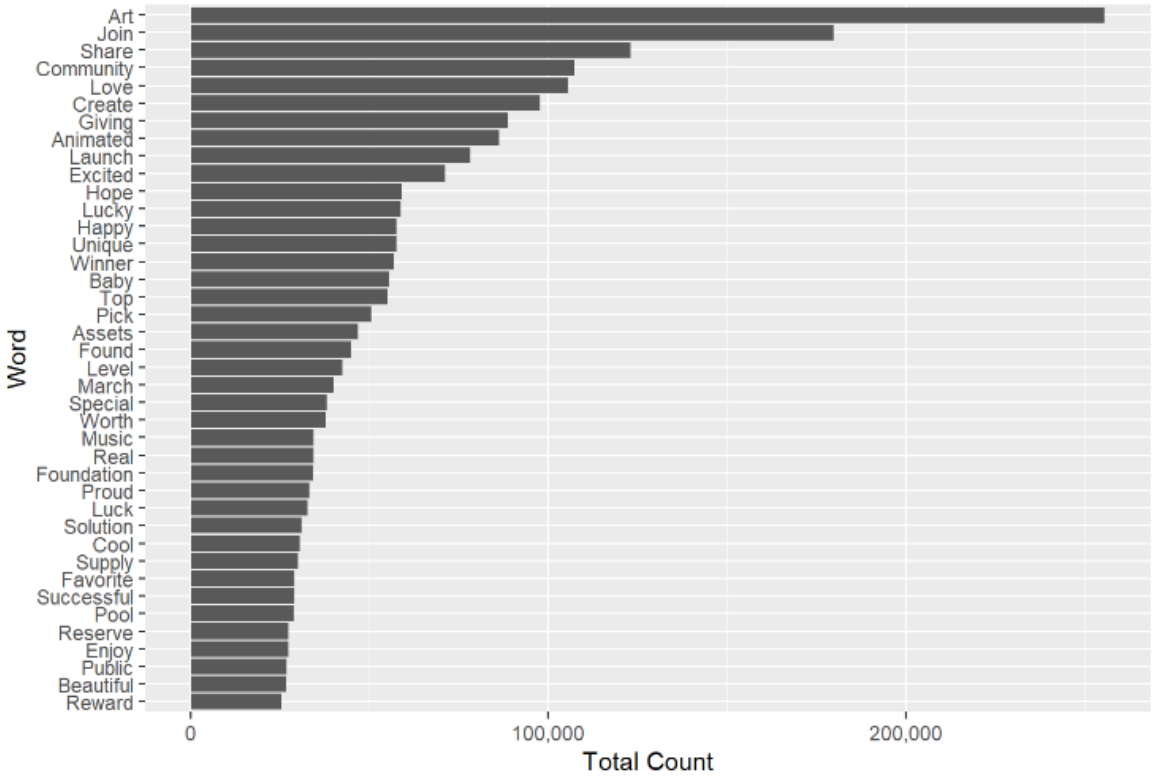


Figure 9. Top forty words associated with the positive NRC association in the "peak" period

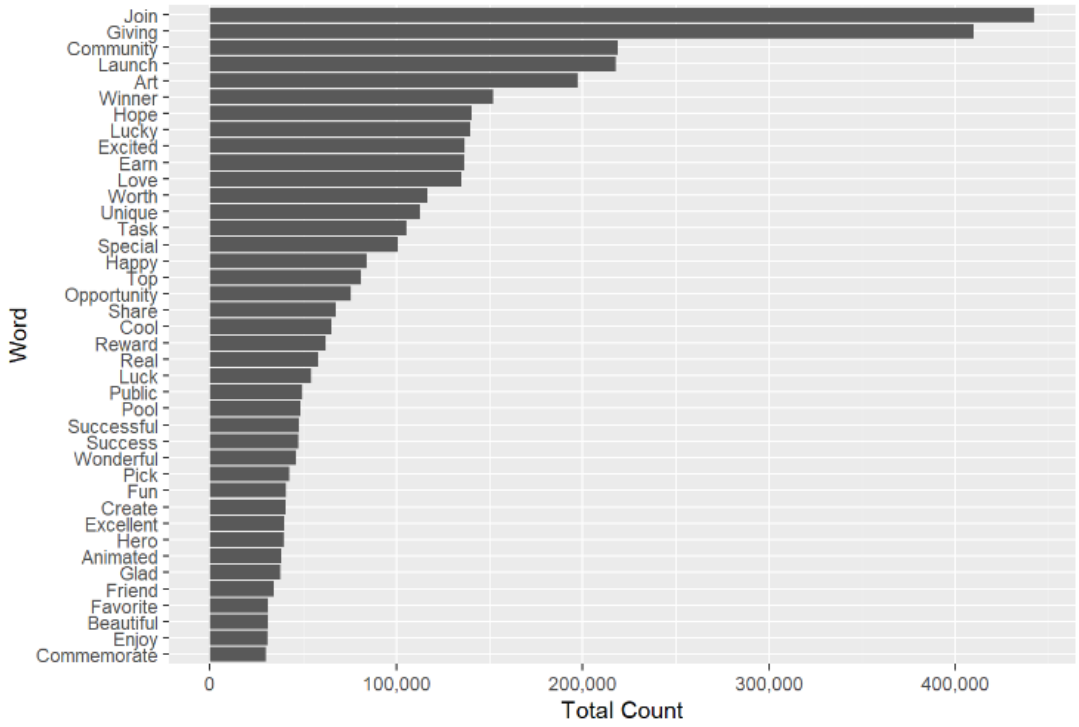
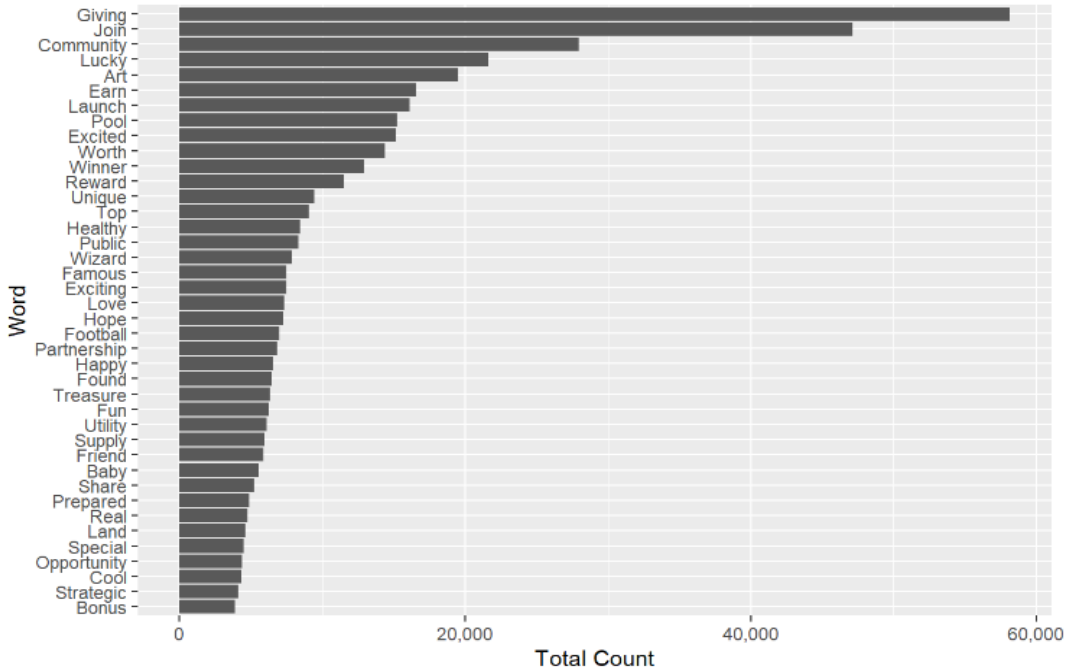


Figure 10. Top forty words associated with the positive NRC association in the "crash" period



Unsurprisingly, “art,” which is associated with positivity, is the most common word of the “hype” period by a large margin. Many of the top words relate to the NFT community like “community,” “create,” and “foundation.” Words that relate to NFT airdrops and giveaways are also represented in the top positive words with “join,” “launch,” “giving,” “winner,” and “reward.” As seen in the most positive tweets, words like “love,” “excited,” “hope,” and “lucky” can be related to the promotion of projects. Along with these promotional related words, financial terms like “growth,” “assets,” and “money” are present as well.

Moving into the “peak” period, “art” is no longer the most used positive word, being replaced by the word “join.” The words “giving,” “community,” and “launch” were more commonly used than art, which dropped to the fifth most used positive word. There is otherwise some variation in the top forty positive words of the “hype” and “peak” periods beyond an increase in total times used. Words like “winner,” “hope,” “lucky,” and “excited” were all still continually commonly used. There was an increase in the use of words related to the promotion of NFT art projects like “love,” “worth,” “special,” and “unique.” The word “earn,” which was the tenth most used positive word, is one of the newly included words in the top forty list of the “peak” period along with words like “success,” “wonderful,” “hero,” and “fun.” “Create” which was one of the most used words during the “hype” period dropped significantly in use during the “peak” period.

There continued to be a lack of significant change from the “peak” period in the top positive words being used during the “crash” period. The top words used continued to include “giving,” “join,” “community,” “lucky,” and “art.” The next group of most used words also still featured words like “launch,” “excited,” “worth,” and “winner.” The most

notable differences between the top words of the “crash” period from the “peak” period is the increase in use of words like “pool,” “reward,” “healthy,” “public,” and “wizard.” There was a decrease in the use of words like “exciting,” “hope,” “love,” and “share.” New inclusions to the top forty of the “crash” period includes words like “treasure,” “partnership,” and “strategic.”

Looking now at the words being associated with the negative NRC category, figures 11, 12, and 13 display the top forty negatively associated words being used by the NFT Twitter community.

Figure 11. Top forty words associated with the negative NRC association in the "hype" period

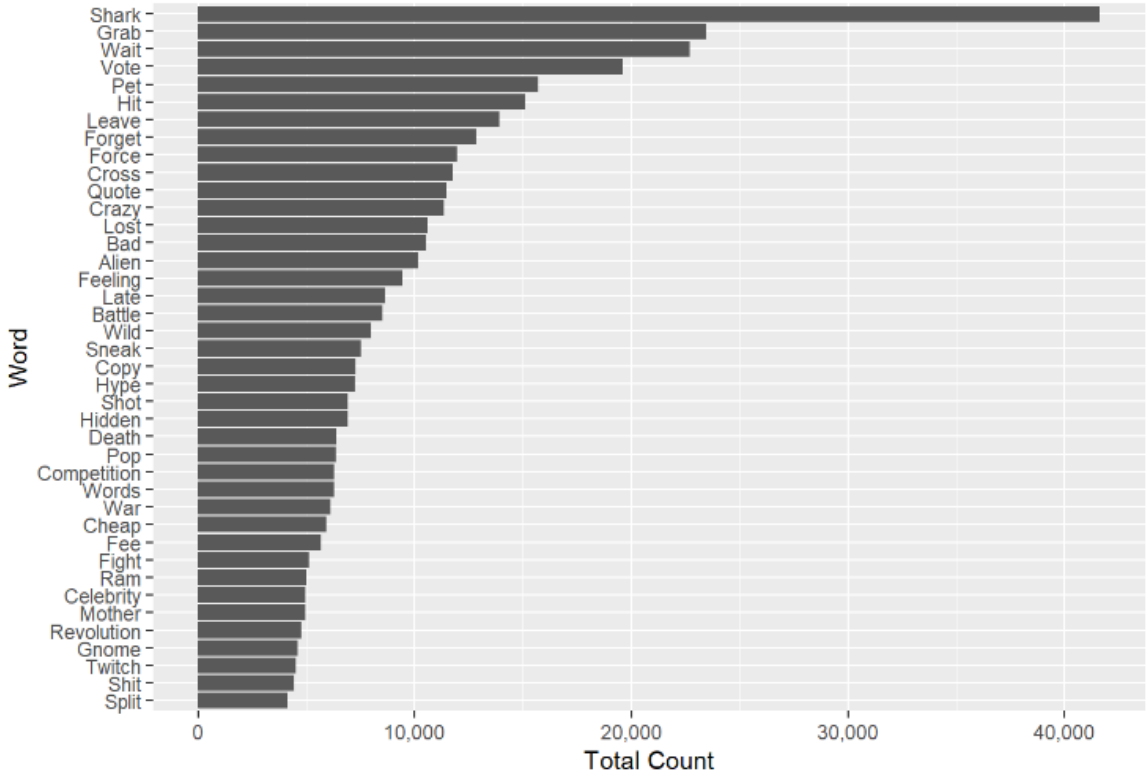


Figure 12. Top forty words associated with the negative NRC association in the "peak" period

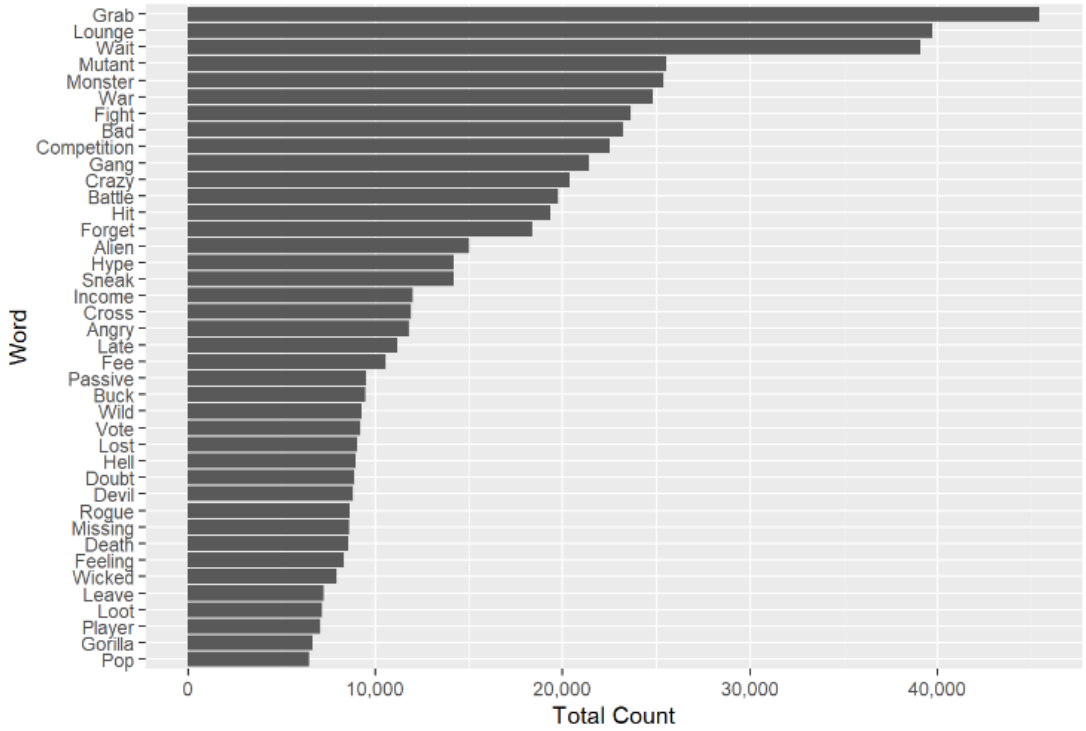
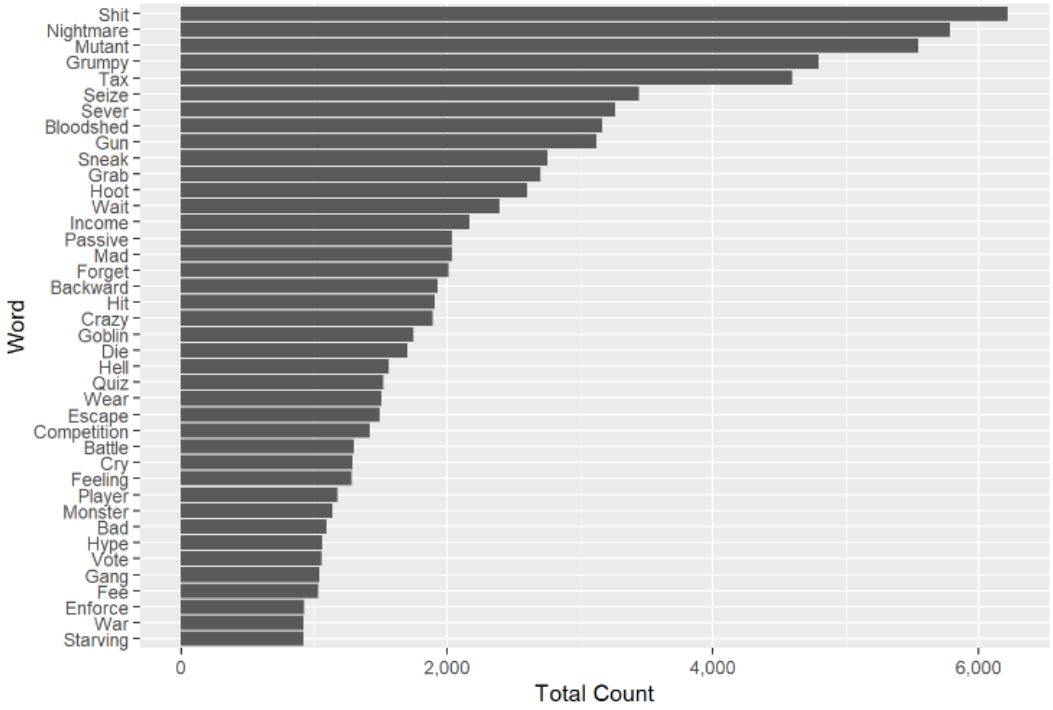


Figure 13. Top forty words associated with the negative NRC association in the "crash" period



Looking briefly at many of the included words sorted into the negative category, the limitation of the NRC sentiment analysis in its inability to detect the context in which words are used is evident. The top negative word used during the "hype" period is "shark," which is hard to quantify in its use without the full context. While "shark" is a term used to refer to someone who profits off loan interest, it is unclear if that is the main usage here. Words like "grab," "wait," "leave," and "forget" which are some of the next most used words could possibly relate more to NFT giveaways and airdrops as being limited run art projects to garner interest and to not leave the opportunity to enter the contest behind. The word "pet" is also unclear in its use, which could also be related to specific NFT projects. Some of the least used negatively associated words appear to be more significant, like "lost," "competition," "bad," and "copy" as they embody some of the negative opinions and events that are seen throughout the previous tweet analysis. Interestingly, the word "hype" is assigned a negative connotation, which proves quite interesting considering the general feeling of "hype" tends to be one of excitement.

In the "peak" period, there was a sharp decrease in the usage of the word "shark," going from the most used word in the "hype" period to not being included in the top forty words. With the question of misunderstood context by the NRC lexicon algorithm, "grab" is now the most used negative word in the "peak" period. Words like "lounge" and "wait" also saw an increase in use along with words like "mutant," "war," "bad," and "fight" which may also vary on relevance depending on context. With the shown reliance and popularity of NFT giveaways, NFT airdrops, and the increased prevalence of GameFi, words like "competition," "battle," and "loot" may be related. The inclusion of words like "gang," "doubt," and "angry" could also be notable considering the greater contexts of

NFTs and the cryptocurrency market but again, without being able to discern the exact context of each individual occurrence, it is hard to determine how accurate that conclusion is.

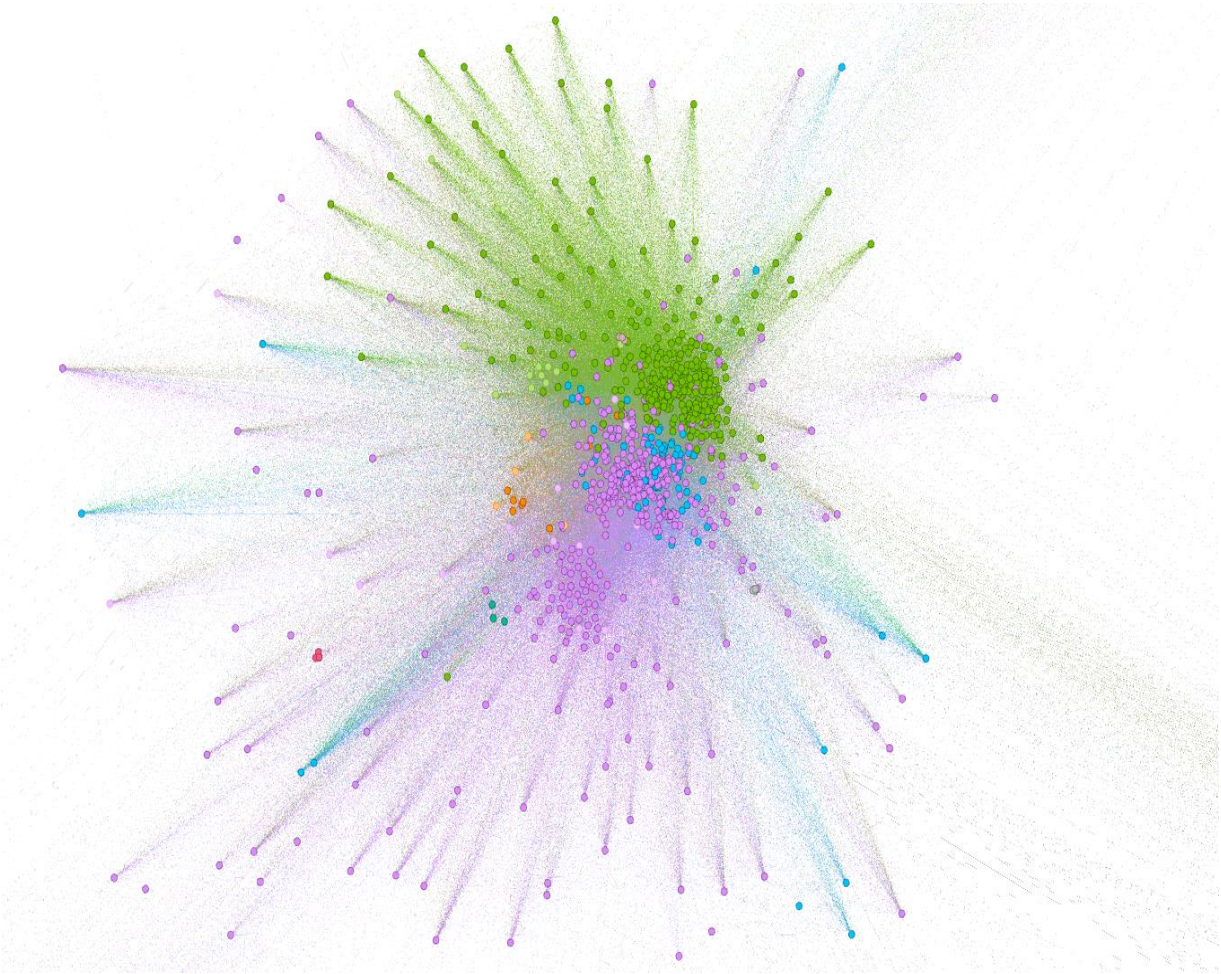
Finally, the negatively associated words of the "crash" period have more variation compared to the other two periods, however, the context of many of these words is once again muddled by the NRC lexicon. The topmost used negative word during this period is "shit," however, as seen in the most negative tweets through the AFINN lexicon, the term "shit" is used in promotional tweets. Words like "nightmare," "mutant," and "grumpy" could also be used in a variety of contexts that may not necessarily be with negative intent. The inclusion of "tax" and "seize" may be notable, especially considering many of the news stories that come out during the NFT market crash. Interestingly, both the words "income" and "passive" are categorized as negative, however, passive income is quite positive for people and an ideal financial goal.

4.3. THE NFT TWITTER COMMUNITY NETWORK

Now knowing what is being discussed by the NFT Twitter community and the overall sentiments of the discussions, the final piece is looking into the breakdown of the NFT Twitter community and their engagement. The method of community clustering creates a connected network of groups through relationships and references (Hu et al., 2016), in this case, through the links created by the community used hashtags. Each hashtag, as a node, is given a weight from its frequency of use (Ullah & Lee, 2017). The network will provide additional insight into the context of community used terminology by distinguishing which groups use certain terms. As seen in the sentiments and topics,

NFTs have many different facets that are being engaged with in different ways. Using Gephi and its network visualization features, figure 14 shows the network of the NFT Twitter community group clusters.

Figure 14. Network of the NFT Twitter Community created in Gephi



With a total of 998 nodes interconnected 154,599 times, the full network is large and busy. The biggest two groups, purple and green, are the most defined. A smaller grouping of blue nodes is interspersed between the purple and green clusters. Two smaller groups, red and orange, are more self-contained but link to both the purple and green nodes.

Cluster 1: Green

Figure 15. Snapshot of NFT art market cluster

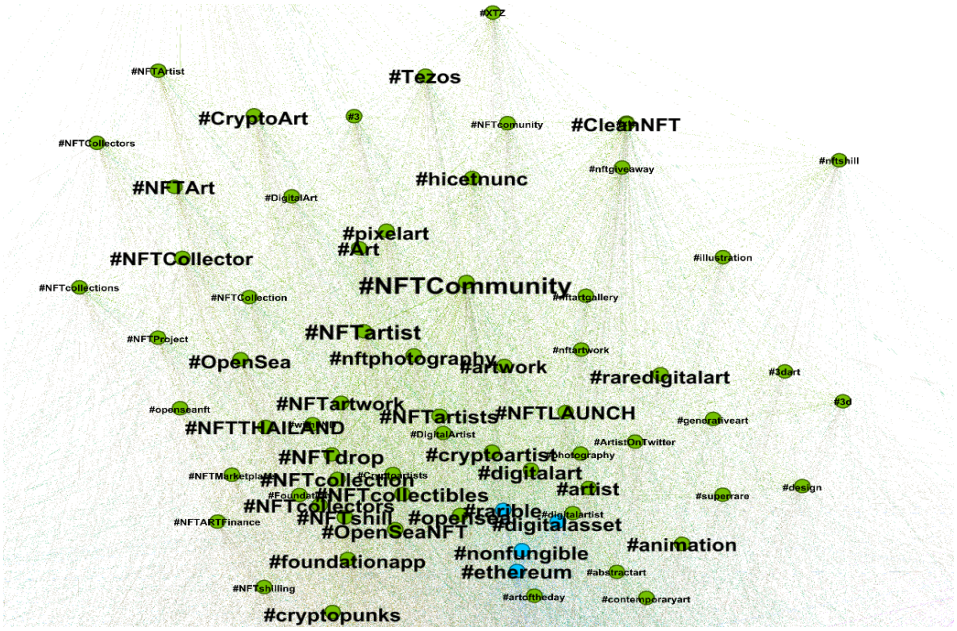


Table 14. Top hashtags used by NFT art market cluster

Cluster	Top Hashtags
NFT Art Market	#NFTCommunity, #NFTart, #NFTartist, #NFTdrop, #opensea, #digitalart #NFTcollectibles, #cryptoart, #NFTcollection, #Tezos, #NFTshill, #HicEtNunc, #NFTTHAILAND, #NFTphotography, #raredigitalart, #artwork, #pixelart, #CleanNFT, #artist, #NFTLaunch, #cryptopunks, #NFTcollectors, #animation, #foundationapp, #Art, #3dart, #NFTARTFinance, #abstractart, #withFND, #NFTMarketplace, #NFTProject, #generativeart, #digitalartist, #illustration, #artoftheday, #ArtistOnTwitter, #NFTcollections, #design, #nftgiveaway, #xtz

This cluster of nodes includes everything related to the NFT art market in a variety of sub-categories, seen in the top hashtags in table 14. Interestingly, the NFT art market is the only grouping to directly refer to itself as a community, as seen in the top hashtags used in this cluster. The main agents mentioned in this grouping are the artists and the collectors, in a variety of hashtag mentions. A variety of art types and styles of

NFT art is included in this cluster like digital art, crypto art, photography, pixel art, 3D art, abstract art, illustration, and generative art showing just how diverse the art market was in form and style. These categories of art that are being produced as NFTs are featured along with specific terms like NFT projects, NFT collections, and NFT collectibles, which all relate to the created artworks. There is also a lot of discussion generated around giveaways, airdrops, and project launches.

The three NFT marketplaces of OpenSea, Foundation, and Hic Et Nunc (which is now defunct) have generated the most discussion in the NFT art market. A single specific community in NFT Thailand generated the most discussion along with a single NFT project in CryptoPunks. Interestingly, only two blockchain and cryptocurrency terms were commonly discussed within this community, which were Tezos and its associated cryptocurrency of XTZ. This correlates to the prevalence of Hic Et Nunc in discussions, as it was a Tezos-based NFT marketplace, which was abruptly closed by owners back in 2021. Additionally, the discussions around Clean NFTs, which were NFTs minted on a blockchain that was considered to have a lower environmental impact, also appears as one of the top forty discussion topics for the NFT art community. Tezos relates to this discussion as well, as a blockchain network that markets themselves as an enabler of clean NFTs. Finally, NFT shilling was also a common discussion within and about the NFT art market, which is reflected in its inclusion.

Cluster 2: Purple

Figure 16. Snapshot of GameFi cluster

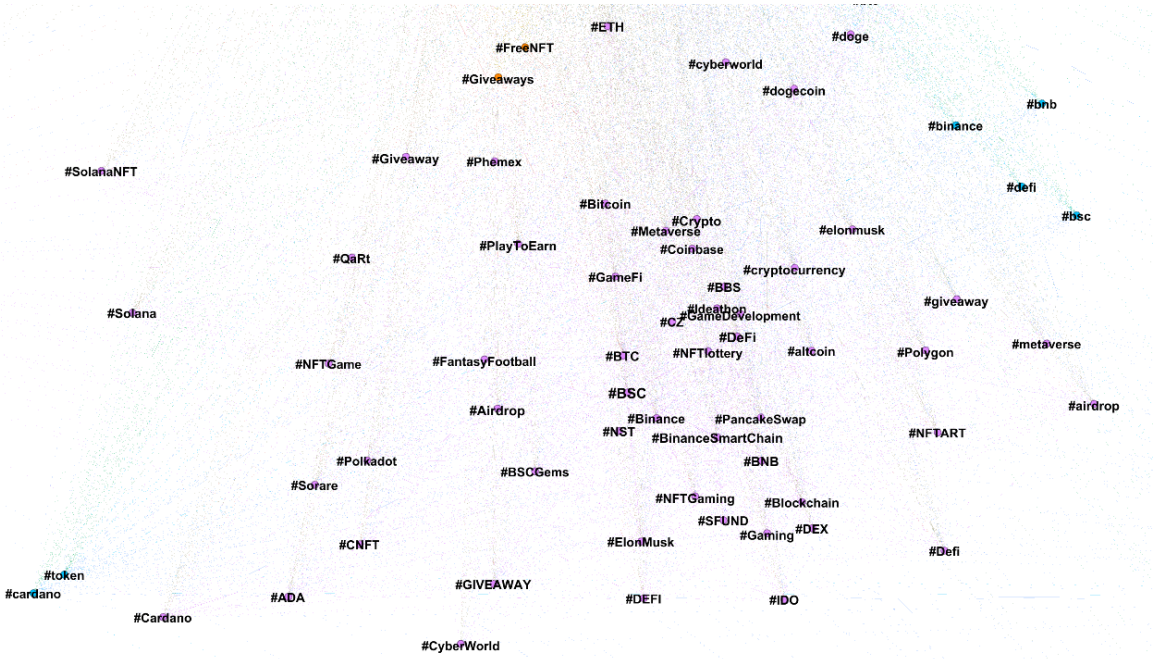


Table 15. Top hashtags used by GameFi cluster

Cluster	Top Hashtags
GameFi	#BSC, #DeFi, #Airdrop, #Crypto, #cryptocurrency, #BinanceSmartChain, #Bitcoin, #Giveaway, #Ethereum, #Binance, #BNB, #BTC, #Metaverse, #Solana, #GameFi, #PlayToEarn, #NFTGaming, #Blockchain, #ElonMusk, #IDO, #altcoin, #NST, #SFUND, #PancakeSwap, #Sorare, #ADA, #FantasyFootball, #NFTS, #BSCGems, #Cardano, #dogecoin, #Phemex, #QaRt, #cyberworld, #CNFT, #NFTlottery, #Polygon, #CryptoNews, #WAX, #Coinbase

This cluster of nodes features everything related to the GameFi segment of NFTs, seen in the top hashtags in table 15. Many of the smaller nodes are connected through the NFTGaming and GameFi hashtag nodes. Specific GameFi games, like Sorare and Cyber World appeared to be quite popular due to their inclusion in the top hashtags. The accompanying hashtags of Fantasy Football and metaverse were commonly used by the GameFi community; Sorare is officially licensed with many European football leagues for its NFT-supported fantasy football leagues and Cyber World is a metaverse

application. NFT Marketplaces like PancakeSwap, CNFT, and QaRt were commonly frequented by the GameFi community as these three sites offered a gamified buying and selling environment that offered financial incentives and rewards for users. One of the main selling points of NFT-enabled GameFi was the addition of the "play to earn" financial incentives linking GameFi to the greater DeFi structure, which are all top forty hashtags used by this community. Giveaways, airdrops, and NFT lotteries for digital items, visual tokens, and game features were common in GameFi games, adding to player incentive and reward value. The GameFi NFT Twitter community disseminated and discussed crypto news quite frequently, noted by the inclusion of the hashtags "cryptonews" and popular culture news websites like Polygon, which discusses GameFi and NFT games. Elon Musk, who became notorious for posting about cryptocurrencies, is the only specific person that was commonly mentioned by the GameFi community.

Since blockchain was the key enabling technology for GameFi, its prevalence in the GameFi discourse is unsurprising. Numerous blockchain networks appear in the common discussion from this community like Binance Smart Chain (BSC), Ethereum, Solana, and Cardano. There were also many specific cryptocurrencies that were popularly used and discussed in the GameFi community like Bitcoin (BTC), Binance Coin (BNB), Altcoin, Ninja Squad Token (NST), Cardano (ADA), Ethereum (ETH), Dogecoin, SFUND, and the crypto tokens of BSC Gems. With the prevalence of financial value being an important feature for the GameFi community, cryptocurrency exchange and trading sites of Phemex, Binance, WAX, and Coinbase were commonly discussed as was the mention of IDO, that stands for initial DEX offering, which projects used to create integrated crypto coins and tokens.

Cluster 3: Blue

Figure 17. Snapshot of DeFi cluster

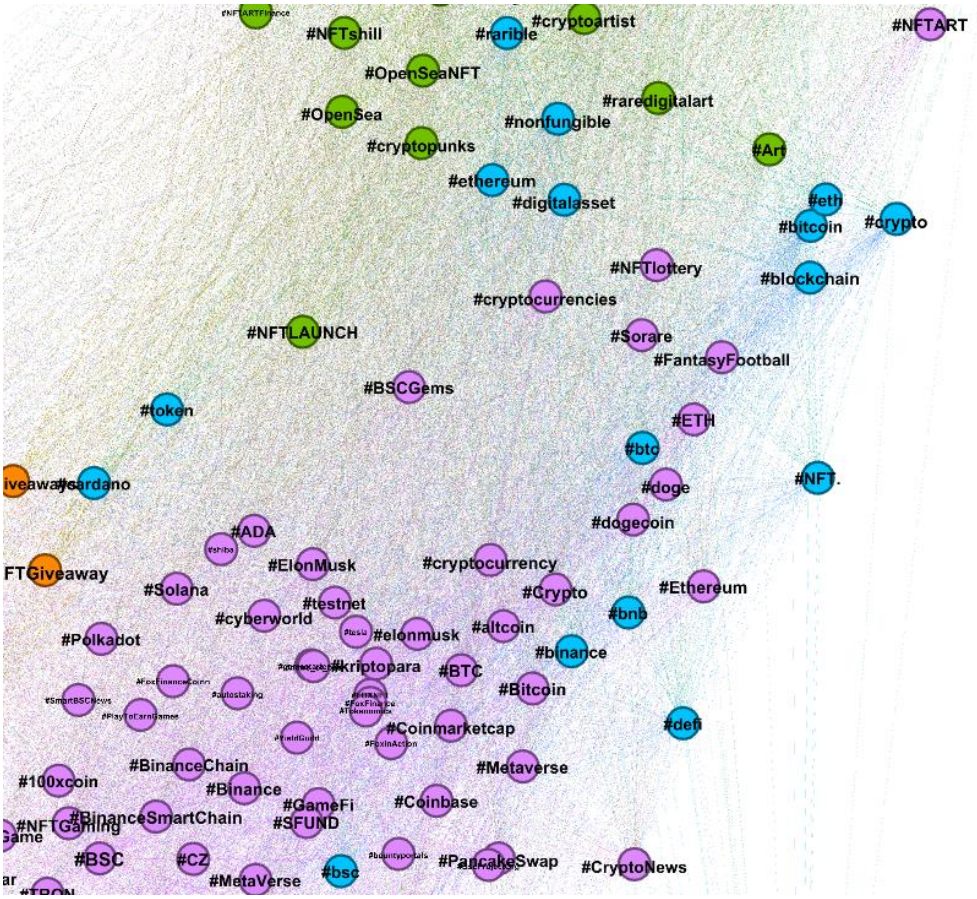


Table 16. Top hashtags used by DeFi cluster

Cluster	Top Hashtags
DeFi	#crypto, #ethereum, #rarible, #blockchain, #nonfungible, #digitalasset, #bsc, #bitcoin, #defi, #NFT, #bnb, #playtoearn, #cardano, #token, #trading, #game, #solana, #gamefi, #polygon, #Marblex, #xrp, #ada, #blockchaingame, #fintech, #money, #investing, #news, #moon, #investment, #launchpad, #cryptotrading, #cryptonews, #LOS, #cnft, #elon, #hodl, #business, #forex, #eos, #nftgaming

This cluster is interspersed between both the NFT art market cluster and the GameFi cluster since both of those clusters are enabled by the overarching structure of

DeFi. This cluster features terms that are integral to the mechanics behind NFTs, as well as the overall cryptocurrency market that powers NFTs. These mechanics are represented in the terms nonfungible, digital asset, token, FinTech (financial technology), crypto trading, investing, and investments which are the core of NFTs and the NFT markets. DeFi systems also enable the play to earn business models of NFT games that blockchain networks support. Four of the most mentioned blockchain networks appear in this category of Ethereum, Cardano, Binance Smart Chain, and Solana. This is along with common cryptocurrencies of Bitcoin, Binance Coin, XRP, ADA, and EOS.

Along with CNFT, Rarible was included in this grouping, opposed to OpenSea which was mainly discussed by the NFT art community, due to its focus on being a more multipurpose NFT marketplace that featured extra financial incentives for users. The GameFi website of Marblex also featured in this grouping for similar reasons to Rarible and Forex, a decentralized foreign exchange, is also present here. Since both NFT art market and GameFi users were always interested in the value of their investments, crypto news was a top discussion for this encompassing group which drove much of the discussion. A community term, HODL, appears in this grouping; this stands for "Hold on for Dear Life," a term that became a meme in the cryptocurrency communities that meant to not sell investments even when the value started to fall.

Cluster 4: Red

Figure 18. Snapshot of African NFT artists cluster

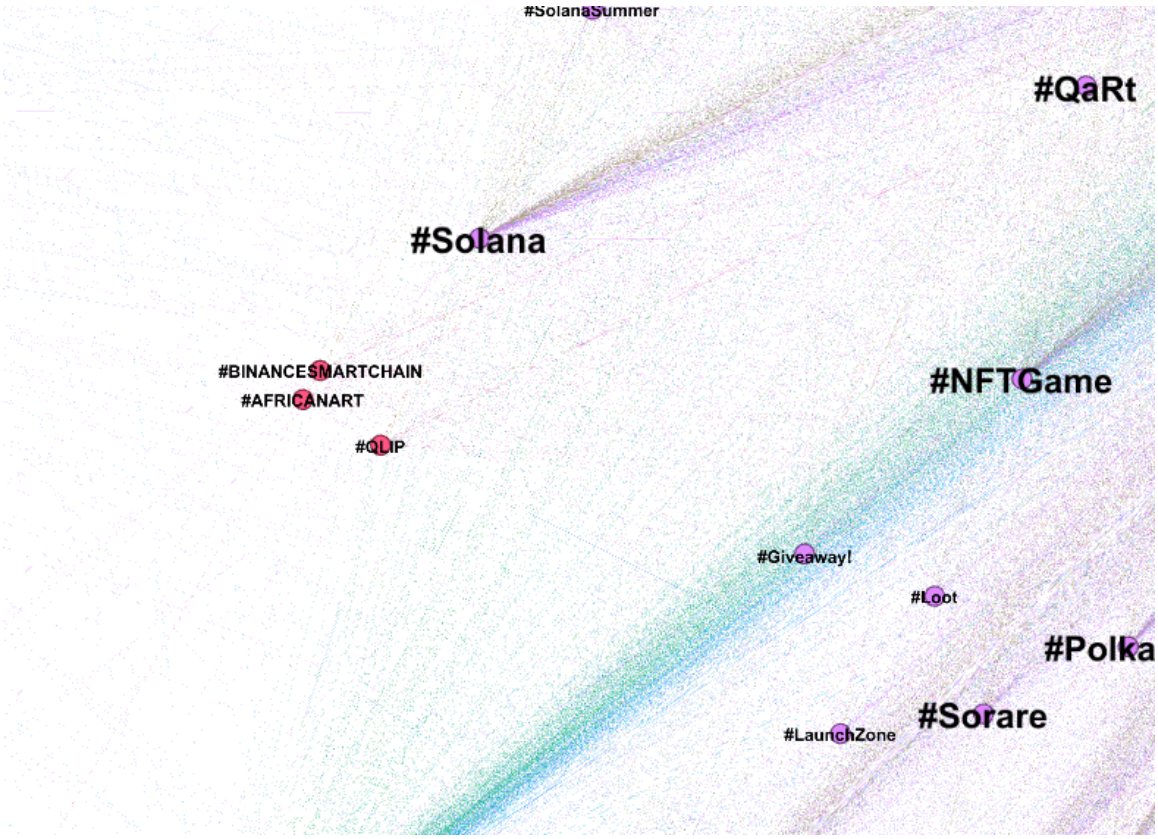


Table 17. Top hashtags used by African NFT artists cluster

Cluster	**Top Hashtags**
African NFT Artists	#QLIP, #Binance, #AfricanArt

In the smallest cluster of just three nodes, this is also the only instance where a specific regional group of artists appear in their own grouping in this network. QLIP is an Africa based NFT platform that focuses on supporting African artists in every NFT market, such as art and gaming (QLIP, 2023). This cluster is linked to the largest green cluster through the NFT community node, placing it in the larger community discussion primarily through its NFT art focus. Looking at the average sentiment ratings of this grouping, the "hype" and "peak" period have the highest positive rating overall, however, this grouping also has the biggest decrease in sentiment heading into the "crash" period.

Cluster 5: Orange

Figure 19. Snapshot of NFT giveaway cluster

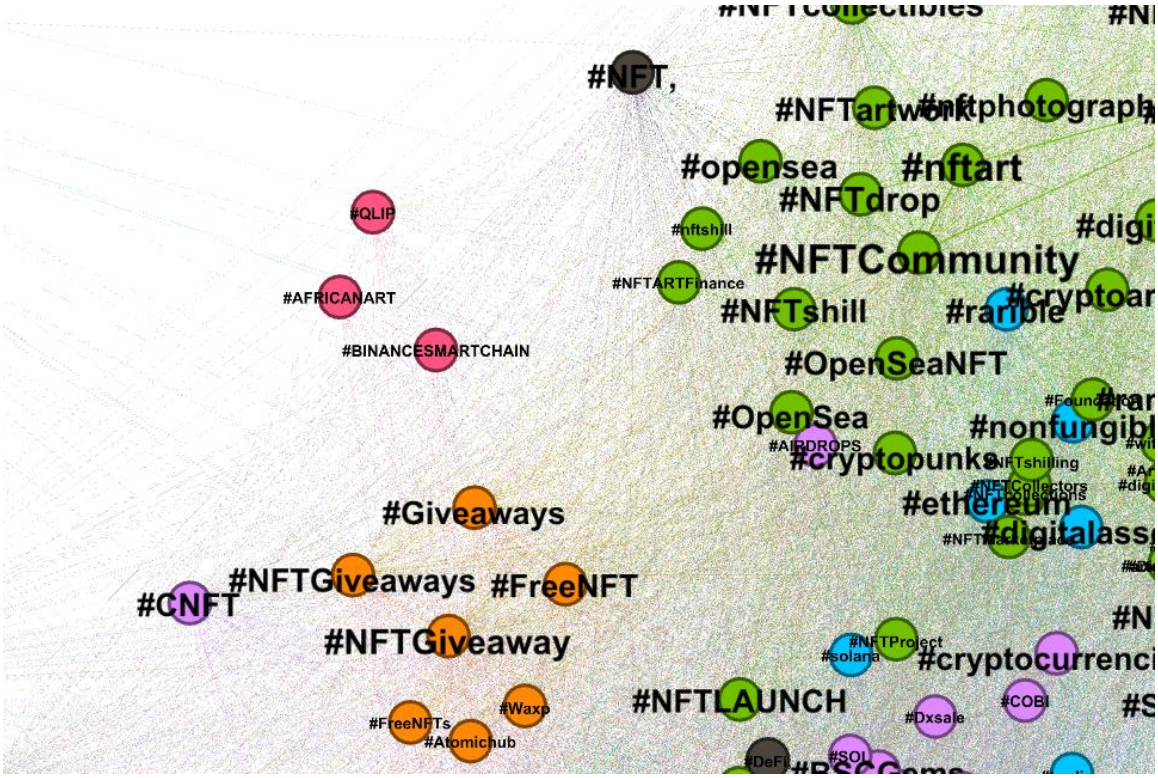


Table 18. Top hashtags used by African NFT artists cluster

Cluster	**Top Hashtags**
NFT Giveaways	#NFTGiveaways, #Waxp, #FreeNFT, #Atomichub, #Rplanet, #FreeMint, #BlackWednesday, #Wooshimemecontest, #NFT!!

Finally, in the last defined node cluster in the network, this group is dedicated to NFT giveaways. As seen in previous clusters, NFT giveaways were a huge part of the NFT Twitter community as both the NFT art market and the GameFi markets both used giveaways to market and promote new projects. Due to the prevalence of giveaways, it created a community based around the overlapping connections to many other areas of the network. Along with the inclusion of all the NFT giveaway phrases, “Free NFTs” also

appears as an alternative phrase. Free minting became an important aspect of NFT giveaways for creators, as some blockchain platforms allowed the creation of NFTs for free. Atomic Hub, a multipurpose NFT platform is included along with WAXP, a cryptocurrency associated with the WAX blockchain. Two specific GameFi games appear in this cluster in R-Planet and Wooshi World (#Wooshime).

Cluster sentiment analysis and volume of activity

Each cluster engaged with NFTs and interacted with the community in different ways, with DeFi terms being a main bridge between the various clusters. The average sentiment over time, shown in figure 20, also varied between each cluster. Since the full data for the "crash" period was not collected, figure 21 displays the average number of tweets per day for each cluster over the collected data periods. Looking at the average number of tweets per day presents a sense of how active the users in each cluster were. In opposition to the previous investigation of the overall sentiments of each period, these two graphs explore the average sentiment rating broken down by period and cluster while comparing the sentiment to how active the clusters were at those points. While the overall sentiment analysis created a look into the overall opinions in the discourse being used by the entire NFT Twitter community, this analysis looks at each individual cluster over time.

Figure 20. Average sentiment for each cluster by period

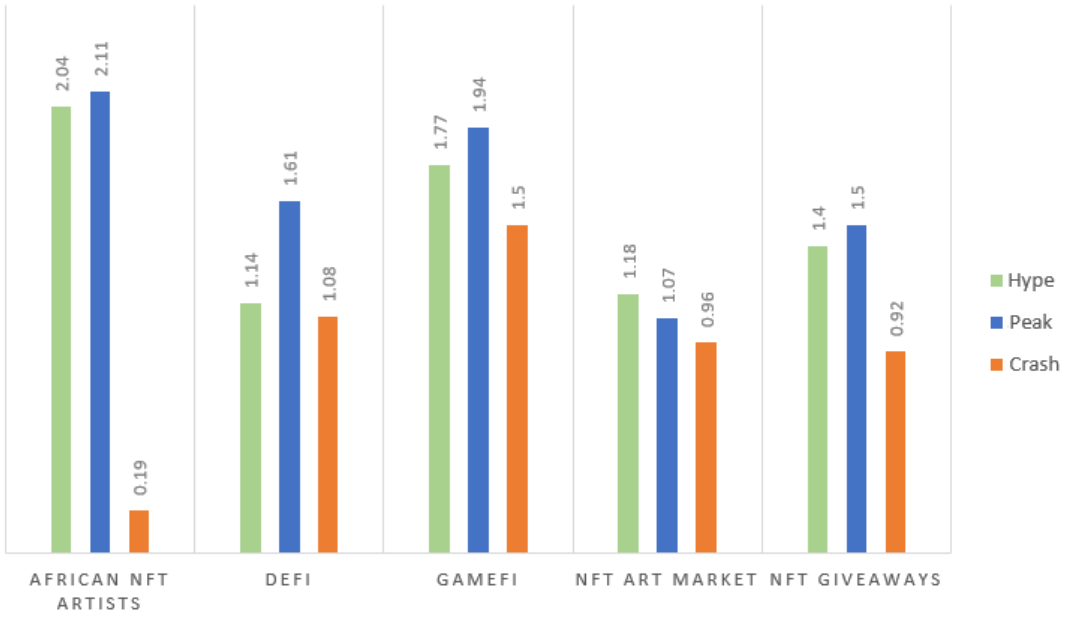
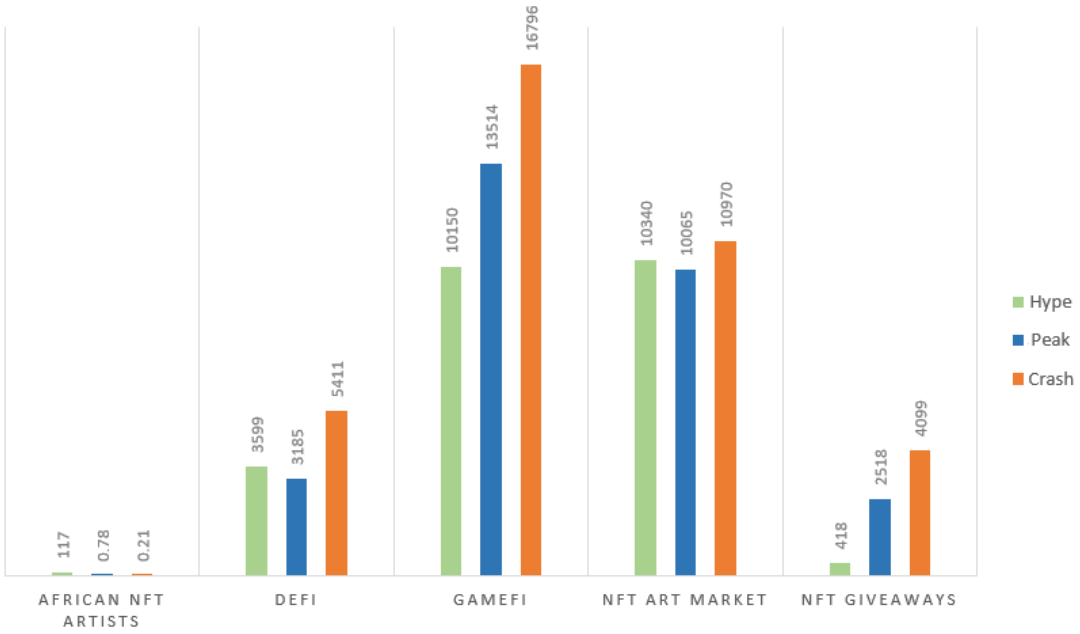


Figure 21. Average tweets per day in each cluster by period



The African NFT artist cluster had the strongest average tweet sentiment overall in the “hype” and “peak” periods, with the sentiment increasing slightly between the two periods over time. The higher sentiments may be affected by the lowest number of tweets per day over the three periods collected. This group was the smallest of the clusters in active users with the lowest numbers of daily average tweets overall, however, this includes only 3 tweets collected during the “crash” period. As only 3 tweets were collected in the small sample of tweets from this period, it is impossible to conclude much from this; while there was a significant drop off in activity between the “hype” and “peak” periods, it is uncertain if that inactivity continued into the “crash” period or if there had been some resurgence of users.

The NFT art market was the only cluster to have a steady decrease in average sentiment over time, while also only starting with a middle range average sentiment of a 1.18. This middling average tweet sentiment in the “hype” period is accompanied by the highest daily tweet average, making the NFT art market the most active cluster in the beginning. The decrease of average tweet sentiment in the “peak” period is matched by a decrease in activity. During the collected “crash” period data, the daily average number of tweets increases while the reflected sentiment continued to drop.

The GameFi cluster had an increase in average sentiment during the “peak” period from the “hype” period, while being only one of two clusters to have a positive increase in the average of daily tweets over time. By the “peak” period, the GameFi cluster was the most active of all the groupings while also possessing the second highest sentiment average during this time. The GameFi cluster appeared to also be the most

active community in the “crash” period by a significant margin as the average tweet sentiment significantly decreased.

The DeFi cluster was one of the less active groups while having above average tweet sentiments. The cluster was the least active during the “peak” period, however, this period possessed the highest average tweet sentiment with a significant increase from the “hype” period. There was a considerable increase in activity during the “crash period, however, this was accompanied by a sharp decrease in average tweet sentiment.

Finally, the NFT giveaway cluster was quite inactive during the “hype” period while having above average tweet sentiment. There was a large increase of activity in the “peak” period where there was only a minor increase in average sentiment. The NFT giveaway cluster continued to be more active during the “crash” period, however, the average sentiment dropped considerably.

CHAPTER 5. DISCUSSION

By exploring the topics being discussed, the feelings towards those topics, and who was engaging in that discourse creates an in-depth, interconnected network of the NFT Twitter community over the period of the collected data. These three analyses can be woven together and connected to create a dialogue surrounding NFTs that aims to answer the research questions of this study. With the available results, this study's discussion will strive to create a timeline of topics and emotions surrounding NFTs in the Twitter community in the 11 months of data collected. The aim is to illustrate the changing perceptions of NFTs from the beginning of popularity into their peak and ending with the eventual market crash.

5.1. MAIN THEMES IN THE NFT TWITTER COMMUNITY DISCOURSE

With the "hype" period's increasing pop culture buzz and its rapidly growing user base over just a few months seen in the increase of activity in total number of tweets and average daily tweets, NFT art was the first big discussion point in the community, while other forms of digital art, like crypto art, were being discussed in smaller amounts. The NFT art market community was also the most active group in the beginning, observed in having the highest daily average tweet count during the "hype" period. NFT gaming was also being discussed in the "hype" period in almost the same amount but it had not yet garnered the same media attention as the NFT market in the early stages of the NFT popularity. While profit was always the end goal of creating and selling NFTs, there seemed to be a distinct lack of business and revenue-based terms in the top forty terms that were being commonly used over time. While words like "buy" and "sell" were being

used, their usage was overshadowed by much of the community who were instead tweeting about giveaways and airdrops. Giveaways and airdrops seemed to drive much of the top discussions in the NFT Twitter community, as they were the most popular methods for artists to market and promote their projects, which resulted in collectors and investors receiving free assets. Even with NFTs at their core being financial assets, it seemed as if there was an initial discourse focus on NFTs being referred to as collectibles over assets in the top terms being used.

The NFT community appeared to primarily build itself around artists and collectors in the beginning, with collectors being the target of much of the discourse. The focus on artists and collectors is reflected in many of the top terms, as a large volume of promotional tweets were intended for them to convince them to invest and buy. Due to this, the NFT community was created around airdrops and giveaways as these contests were reflected in many of the top terms being used. Creators requiring interested collectors to like tweets, follow accounts, retweet promotional tweets, join groups, tag other accounts in their networks, and use certain project name hashtags as entrant rules; all of which appeared in the commonly used top forty terms. This phenomenon seemed to result in a community artificially created around the promotion of these projects, as the community was turned into a promotional network, which generated interest, buzz, and value in the NFTs being offered for the goal of profits from assets. Cryptocurrencies and blockchain networks were also popular topics as the enabling technologies behind NFTs. Ethereum was the most mentioned blockchain for NFTs through the collected data periods, with Binance being the most referred to crypto exchange platform.

With the increase in popularity of NFTs heading into the peak of NFT transactions, garnering attention amidst an oversaturation of projects and artists in a booming cryptocurrency market became vital which probably led to the increase in airdrop and giveaway tweet volume. Competition would have been high as the market became flooded with buyers and sellers all vying for profits in a volatile, dynamic, but incredibly valuable, financial market. The peak of the NFT Twitter activity saw a sharp increase in the use of terms related to giveaways and airdrops, likely in response to the oversaturation of projects as many people wanted to get involved while the NFT market was booming. Promotion of NFT projects seemed to dominate the discussions and discourses. NFT art, the creative outcome of many of these projects, became less of a focus for the community who were instead competing for the attention of collectors and buyers as related terms began to be used less. The shilling of NFTs also became a growing topic over time, a main criticism of those selling on the NFT art market. While the NFT art market boomed, the NFT gaming market also gained in popularity, which is reflected in the steadily increasing average daily tweets, utilizing many of the same promotional aspects as giveaways and airdrops to gather interest.

The dominance of giveaways and airdrops tweets as the tactic to create invested communities around projects saw the related words continually increase in usage during the peak of the NFT activity on Twitter. As the NFT community kept increasing in users, the focus on the previous two main parties of artists and collectors dwindled. The NFT community on Twitter greatly expanded to include users like video gamers as GameFi became more and more popular with the increase of NFT gaming projects.

Referring to NFTs as collectibles decreased over time, potentially due to the growing awareness of the community and their inherent knowledge of NFT as financial assets. This shift in discourse could also be the result of the increasing prevalence of buyers with no internet to collect NFTs for personal use. Instead, buyers and investors were using NFTs to quickly make a profit by buying and immediately flipping for greater profit during the peak of financial value (Ko et al., 2022). Even still, the community appeared to continually be successful in promoting and selling NFTs without heavily relying on clear business-driven terms. Smaller sub-community pockets also began to emerge and be discussed primarily through community used hashtags. There were more individual projects (like Moonie NFT), geographically contained NFT communities (like NFT Thailand), and specific people (like Elon Musk) being commonly tagged in the discussions.

The competition in the NFT markets was also seen in the growing number of mentioned cryptocurrencies, blockchain networks, and NFT marketplace websites over time. While Ethereum and OpenSea remained on top throughout the period, other options began to make ground and grow as viable alternative options for users. Discussions began to branch out to other social media and communication applications, like Discord, creating interconnected networks of users across multiple platforms. This growing interconnectedness of the NFT community across platforms is also reflected in the increased discussion about the metaverse in the NFT discourse. The metaverse became a buzzword for many businesses who were trying to create an immersive and interconnected virtual world for consumers where NFTs became a popular form of assets for financial transactions in these networks.

The trajectory of an increase in the promotion and marketing of new NFT projects continued into the "crash" period. Artists were still creating and launching projects, needing to keep getting people invested in the project's success even while the market started to plummet in value. From this, the focus of NFT art appeared to fall even lower as NFTs started to lose their value and people began scrambling to move assets as fast as possible before they were deep in the red ledgers. While the NFT art markets began crashing, the GameFi market seemed to possess enough inherent value to gamers to become the biggest NFT market during this time with an increasing average daily tweet count. GameFi games attracted players through incentives and rewards of earning cryptocurrency and digital assets, which users may have tried flocking to during the crash to try and solidify their cryptocurrency portfolios that were dropping in value.

Near the end of the collected data, there was also a drop in the discussion surrounding the NFT community itself, potentially matching a significant drop in active communities and users as the market began crashing. Based on the investigation of many of the projects that were mentioned in the data throughout this study, most of the NFT projects, websites, and community groups appeared defunct or inactive from around the time of the market crash in June 2022, if not before then. Despite the collapse, the hashtags being used near the end of the collected data were still discussing new communities, projects, and websites, showing that new projects and networks were still being launched.

5.2. SENTIMENTS IN THE NFT TWITTER COMMUNITY DISCOURSE

Overall, the sentiment analysis seems to show that positivity-driven discourse dominated over the collected period, even during the "crash" period. Considering the innovative factors that mark both the "hype" and "peak" periods (Bower & Christensen, 1995), the overall increasing sentiment average between the two periods shows the trajectory of NFTs from increasing adoption as a technology to the height of their use. Both periods saw an increasing number of users successfully making profits off their NFT assets, which is expected to make users happy and excited. The heightened emotions of positivity and anticipation also reflects this optimism of those using NFTs at the time. As seen in the most positive tweets through the AFINN sentiment analysis lexicon, there was a sense of excitement for the capabilities of NFTs. The emotions of positivity and anticipation being the two highest total number of words used in the NRC sentiment analysis lexicon follows the same emotional trajectory. The emotion of joy also reflects much of the community sentiments behind the promotion of projects and artistic creations on the new markets where users were ultimately finding increasing financial success on. As more and more users made money, especially where those users had not found this level of success in the pre-existing digital art markets, positive emotions were understandably high. Since NFTs were a newer phenomenon having just found popularity that was riddled with uncertainty, the emotions of surprise were also significant.

The sentiments of some of the positive tweets seem to align with the academic literature that mentions the promise of an NFT supported open, diverse art market for the creative community to utilize (Patrickson, 2021). Many of the words in the discourse that carry associated sentiments match the main themes. Art is, unsurprisingly, the most used

positive word in the beginning "hype" period, as artists where the main initial adopters of NFTs. Words like "create," "launch," "share," and "community" centred around the excitement in the creation of a large artistic community using the new markets to sell creative works. Words like "join," "giving," "winner," and "lucky" were also positively associated that related to the many giveaways and airdrops, creating a sense of positive camaraderie among the growing community. Financial terms like "growth," "asset," and "money" are also tied to positive emotions, tying into the users' financial excitement through NFTs value.

Moving into the height of the NFT Twitter activity, the "peak" period having the highest average sentiment score probably reflects the increased activity of NFT discussion, NFT usages, and the popularity of NFTs all on the backdrop of an overall thriving market. However, looking at the context behind many of the positive terms used, the overwhelming positivity appears hollow in several ways. There were many positive terms being used but much of it was used in tweets directly marketing and promoting projects to investors and buyers. The sentiment word associations of these tweets may be positive but how accurately they reflect the community beyond users wanting to make as much profit as possible is uncertain. Profit is a positive thing for artists and collectors; the goal of utilizing the NFT market. However, a community in potential heightened competition with each other to make the most profit, which was being mobilized by creators as an active network for promotion, advertising, and marketing, does not seem to quite fit into a tangibly positive community environment that was reflected in some of the investigated tweets.

To not be entirely subjective about the idea that profit as the only motivator for the creation of the community as being either positive or negative, the underlying issues that appear due to valuation of the NFT market can lead to a fuller discussion. Even with the booming NFT markets, the value in cryptocurrencies remained quite volatile and not everyone made profits (Nizzoli et al., 2020). Many users would have suffered financial losses, even before the market crash, which would have presented itself as anger in the tweets. However, the lack of terms associated with the emotion of anger was surprising. There was also an expectation of uncertainty surrounding NFTs as a newer phenomenon during the "hype" period, however, this was also not reflected in the overall sentiments; this might have been because the emotion of fear may have been too strong while anticipation was considered positive.

With a flourishing market like this, people wanted to get involved and make their own share of the money while the value was high which is reflected in the increasing user activity (Hamrick et al., 2021). Due to this, fraud became widespread (Cornelius, 2021). Copyright and intellectual property rights had little recourse in this environment to be monitored and enforced when artwork was stolen, minted, and sold by someone other than the creator (Cornelius, 2021). The reality of fraud and infringement of intellectual property rights was reflected in some of the most negative tweets, which also gave examples of detection and enforcement over stolen art relied on community policing to name and shame fraudsters. This method of naming and shaming, however, would have rarely worked for the original creators to get recompense for financial loss or damages, as it was almost always too late since the transactions had already been conducted and the funds transferred, usually many times, by that point.

As previously discussed in the literature review, much of the academic literature warned about this darker side to NFTs, despite their promising attributes, and it did appear in the community discourse. Reflected in a handful of tweets that were analyzed, while NFTs were heralded as having the potential to stop art fraud and theft through their traceability of ownership and digital provenance, both fraud and theft seemed to continue (Patrickson, 2021). Scammers and grifters performed questionable financial transactions which were reflected in some of the tweets and associated sentiment words. People who may not have quite understood the financial landscape of the cryptocurrency market nor the mechanics of NFTs still wanted to be involved to make what appeared to be quick financial gains, whether from their pop culture buzz or word of mouth from people they knew (Cornelius, 2021; Kshetri, 2022). In these cases, unfortunately, malicious parties preyed on users who may not have quite understood what NFTs exactly where, how they worked, and what buying a NFT entailed to make profit of the chaos of the hype (Kshetri, 2022).

There were also some additional words and terms like “lost,” “competition,” “seize,” and “bad” that appeared in the top terms commonly used that would have reflected many of the news stories about scammers getting arrested, like the Mutant Ape Planet story previously mentioned. “Fees” is a negatively associated word that appears commonly as well, which may be in direct reference to the usually quite expensive “gas fees” that needed to be paid to mint NFTs (Gayvoronskaya & Meinel, 2021), especially in the beginning before low cost or free minting was more readily available. Lastly, “celebrity” is also a significant inclusion in the common negatively associated words. Celebrities were some of the first non-artists groups that adopted NFTs to bolster their

brands and influence. Many celebrities have come under fire for shilling to and scamming their fans by pushing NFT consumables to make money, leaving many critics and detractors questioning NFTs and the motives behind those selling (Katte, 2022).

With the context of the NFT market crashing, critics posting "I told you so" articles, and constant news stories of people losing everything while scammers were getting sent to jail for fraud, the beginning decline of opinion matches the state of NFTs at this time, as the average sentiment of tweets in the "crash" period decreased from the previous period. The sentiments around GameFi stayed stronger compared to the sentiments around the NFT art market, which hit all-time lows as many projects and websites that were observed during this research had become defunct and communities became inactive. However, where the average sentiment rating of the tweets collected in the "crash" period decreased with the AFINN lexicon, the NRC lexicon showed that the words being used during this period were still more positive than negative.

This discrepancy between the two sentiment lexicons could be caused by a couple of factors. Knowing that creators were still launching and promoting NFT projects even as the market began crashing, meant that giveaways and airdrops were still commonly posted. Due to the promotional nature of the giveaways and airdrops, positive terms were still dominant in these tweets and were reflected in the top terms. There may also have been a decrease in overall NFT users by this point, as communities, websites, and projects were becoming defunct and inactive, and the only active NFT users on Twitter were trying to promote and sell their projects to a dwindling market. The time limitations that resulted in less data collected also played a part in the discrepancy; the average

sentiment also dropped due to smaller amount of data collected and had more been collected, the trajectory may have looked different.

5.3. THE NFT TWITTER COMMUNITY NETWORK

Through the background and literature review of this study, it appeared much of the popular media and academic attention around NFTs always had a focus on the NFT art markets. Contrary to this focus, the GameFi market appears to be the biggest and most active between the two communities through the average daily tweets. The GameFi cluster is made up of game developers and video gamers as the main agents interacting with NFTs and the technology. Gamers were attracted to GameFi games through their play to earn incentive models of financial rewards, which are featured in the top hashtag discussions. While both the general media and academic literature seemed to pass over the existence of GameFi, there were a couple of news sites that targeted certain audiences who were covering the emergence of GameFi like Polygon, a dedicated video game news site. Despite the lack of outside coverage, the GameFi community bolstered a positive trajectory of average sentiment from the "hype" and "peak" period, peaking at a sentiment average of 1.94. By the "crash" period, GameFi had the most active user base, which potentially reflected the inherent value in the play to earn NFT gaming model.

Despite the heightened media attention and academic literature focusing on the booming NFT art market, the breakdown of this community is a bit surprising. The average tweet sentiment starts low, the second lowest of all five featured communities, with a 1.18 in the "hype" period. From there, the average tweet sentiment begins steadily decreasing, also being the only community that featured a decrease in average sentiment

heading into the “peak” period of the data. This may have been caused by the prevalence of promotional and marketing tweets being the most common Twitter posts in the “hype” period while the increasing criticisms of NFTs as a viable investment became more common in the media as the group of detractors became larger and more vocal during the “peak” period. Similarly, to the GameFi network, the NFT art community is composed of two main agents: artists and collectors. The artists that were creating NFTs did so in a variety of styles, like pixel art and 3D art, which is reflected in the top hashtags used. The collectors of the community were the focus of much of the discourse, as the investors and buyers of NFT projects. Sub-communities were created by artists and creators around their projects using the marketing and promotion strategies of airdrops and giveaways. There was a prevalence of many top words and hashtags that revolved around users entering these contests by enticing users to disseminate projects through their personal networks for the chance to win free assets. These airdrops and giveaways turned the NFT community into active advertisers, asking users to tag other user accounts, join communities, and follow accounts to be entered into these contests. Sub-communities were also created around geographic locations, like NFT Thailand, through the prevalence of community used hashtags.

One of these geographical sub-communities appeared as their own community cluster in the network analysis. An African NFT artist community was created around a NFT marketplace website called QLIP. Based on the average daily tweets over each period, the community was mostly active during the “hype” period and became far more inactive by the “peak” period with a sharp decrease in Twitter posts. The average tweet sentiments of this community were the highest among all five clusters in the “hype” and

"peak" periods, implying that QLIP fostered a supportive, positive environment for African NFT artists but as seen by the sharp decline in tweets in the "peak" period, the community was not sustained for long.

DeFi having its own clustered network connecting to all the other communities shows the importance of the DeFi structures to all the NFT communities. It is the backbone of NFTs as the enabling structure built on blockchain technologies. Cryptocurrencies enabled NFTs to have value as financial assets. Many of the collectors and investors were not new to the cryptocurrency landscape like many artists were. With the large amounts of money being exchanged, especially in the top NFT projects, investors already had to be well established with cryptocurrency assets in their financial portfolios. The DeFi community follows similar sentiment trajectories to most of the other communities; there was an increase of positivity into the "peak" period from the period before with a large decrease into the "crash" period. NFT giveaways being reflected in their own network that is connected to all the other communities also shows its importance to the NFT landscape. The prevalence of giveaways as promotional and marketing tactics created groups of people connected to the multitude of NFT projects that launched. There was a sharp increase in tweet activity during the "peak" period, potentially reflecting the heightened activity and competition of the NFT markets at the height of the NFT market boom.

5.4. LIMITATIONS

Using Twitter for data collection does have some inherent limitations. Twitter is full of bots that both generate content and posts automatically with no human

involvement. There are conflicting reports on how many Twitter bot accounts are active at any time with numbers ranging between 5% and 11% depending on the study (Chu et al., 2012; Duffy & Fung, 2022;). The bot accounts are usually hard to pick out as different from regular human accounts as they are usually programmed to mimic human-generated content (Wischnewski et al., 2022). While bot-generated content is slightly counterproductive, users do interact and engage with bot-generated content (Wischnewski et al., 2022), making it embedded in the discussions and discourse of the community.

The format and structure of the tweet text also introduces some limitations. Character limits on tweets can lead to issues of fragmented messages or multiple emotions being portrayed that sentiment analysis cannot distinguish between (Kontopoulos et al., 2013). Trolling, sarcasm, and hyperbole can lead to issues in sentiment analysis. The terminology used by the community is not consistent. There are many offshoot projects that might not be flagged as NFT, despite using the technology (Kontopoulos et al., 2013). Tweets that are incorrectly (or miscategorized) through sentiment analysis were more evident when visualized and looked at an individual level. Using frequency tables and sentiment analysis to explore a large amount of data also addresses issues of Twitter conversation biases and the echo chamber of opinions when looking at specific tweets and discussions that can become one-note and too focused on a certain path of thought and opinion.

The limitation that played a large part of this analysis and discussion was the inability of both the AFINN and NRC sentiment analysis lexicons algorithms to account for the context in the usage of terms. The misclassification of terms led to moments of

disconnect between what the data was showing and the overall context within the NFT markets. Where these disconnects were most evident, it was possible to perform an individual analysis, however, it would be infeasible to perform that level of analysis to each tweet to determine the correct context, considering the amount of collected data.

CHAPTER 6. CONCLUSION

6.1. THE FUTURE OF NFTs

This research was first conceived during the peak of the NFT markets, where many were finding financial success with no prediction of when the NFT bubble was going to burst. Throughout the research process and heading into the final stages of writing, the once burgeoning market had collapsed to become something entirely different. Many of the projects, dApps, websites, networks, users, and communities were no longer active or had become defunct by the time of writing this research. After a period of incredible highs, NFTs now find themselves in a period of incredible lows. Despite all the promise NFTs seemed to offer, the negatives of the technology seemed to have taken hold and eventually led to the downfall. That does not mean, however, the phenomenon of NFTs did not have its merits. NFTs may be able to bounce back to become a more stable crypto token market. There is also a chance that NFTs fade away as a technology that was not sustainable enough to become truly disruptive but that does not invalidate the multiple research paths that could still shed light on their phenomenon.

6.2. FUTURE RESEARCH

The crash of NFTs, however, does not negate the outlined promises of the technology. Further research into the exact why NFTs failed would create a framework to rebuild the foundations of NFTs as a potential disruptive technology that supports its users who quite clearly profited off the technology in many ways. This rebuild may lie in an examination of how legislation and laws failed to properly account for the DeFi world

and cryptocurrency. While disruptive technologies are meant to upset the status quo, they still need to have some form of regulations, as untethered users cause unpredictability and chaotic environments that enables those to seek to maliciously use technologies for personal gain.

Research into rules, laws, and legislation may help find a good compromise between a large, open market and some form of regulation to prevent fraud and exploitation. These compromises could give businesses and developers groundwork to refine their systems to better serve those using them. More research into the cryptocurrency environment and how it facilitates scammers and fraudsters seemingly quite successfully would also be useful to determine ways to prevent these major issues from perpetuating. Further research into the structure and landscape surrounding NFTs would provide valuable knowledge for NFTs to learn from its successes and failures; to allow innovators to pick up the pieces and shape the technology into something more sustainable in its next iteration.

6.3. FINAL REMARKS

This research strove to begin filling in a knowledge gap of how the users interacted and shaped NFTs to become the phenomenon that they were. It may now not be the most relevant knowledge gap to fill with the collapse and state of NFTs, however, there is still merit in this type of research. It explores the social contexts that many researchers failed to properly recognize; that while NFTs were primarily a financial entity with the end game of profit, the users themselves were a strong piece behind NFTs dance with success. Understanding who was creating the success of NFTs and how they were

engaging with the technology to create that success produces valuable guidance for the future of NFTs and, perhaps more likely, any future financial disruptive technologies.

REFERENCES

Adner, R. (2002). When are technologies disruptive? A demand-based view of the emergence of competition. *Strategic Management Journal, 23*(8), 667-688. 10.1002/smj.246

Alonso, S. L. N., Jorge-Vazquez, J., Fernandez, M. A. E., & Forradellas, R. F. R. (2021). Cryptocurrency mining from an economic and environmental perspective: Analysis of the most and least sustainable countries. *Energies, 14*, 1-23. https://doi.org/ 10.3390/en14144254

Ape Just Shit. [@ApeJustShit]. (2023). *Ape Just Shit Twitter Biography*. Twitter. https://twitter.com/ApeJustShit

Bao, H., & Roubaud, D. (2022). Non-Fungible Token: A systematic review and research agenda. *Journal of Risk and Financial Management, 15*(5). 1-10. http://dx.doi.org/10.3390/jrfm15050215

Barradas, A., Tejeda-Gil, A., & Canton-Croda, R. (2022). Real-time big data architecture for processing cryptocurrency and social media data: A clustering approach based on k-means. *Algorithms, 15*(5), 1-11. 10.3390/a15050140

Beckett, L. (2022, January 29). *'Huge mess of theft and fraud:' artists sound alarm as NFT crime proliferates*. The Guardian. https://www.theguardian.com/global/2022/jan/29/huge-mess-of-theft-artists-sound-alarm-theft-nfts-proliferates

Best, J. (2020). Signposts turn to twitter posts: Modernizing the public forum doctrine and preserving free speech in the era of new media comment. *Texas Tech Law Review, 53*(2), 273-310. https://heinonline.org/HOL/P?h=hein.journals/text53&i=293

Binance. (2023). *Welcome to Binance*. https://www.binance.com/en/about

Blondel, V., Guillaume, J., Lambiotte, R., & Lefebvre, E. (2008). Fast unfolding of communities in large networks. *Journal of Statistical Mechanics: Theory and Experiment, 10*, 1-13. https://dx.doi.org/10.1088/1742-5468/2008/10/P10008

Bower, J., & Christensen, C. (1995). Disruptive technologies: Catching the wave. *Harvard Business Review, 73*(1), 43-53. https://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=9501303527&site=ehost-live

Bruns, A., & Burgess, J. (2012). Researching news discussion on Twitter. *Journalism Studies, 13*(5-6), 801-814. https://doi.org/10.1080/1461670X.2012.664428

Cascone, S. (2022, March 28). *Police arrest two 20-year-olds for allegedly conning collectors out of $1 million – with ice cream-themed NFT artworks*. https://news.artnet.com/market/frosties-nft-arrest-2090659

Castrodale, J. (2022, May 5) *Starbucks is launching its own NFT collection*. https://www.foodandwine.com/news/starbucks-nfts-perks

Chainlink. (2023). *What is GameFi?* https://blog.chain.link/gamefi/

Chandrasekaran, D., Tellis, G., & James, G. (2022). Leapfrogging, cannibalization, and survival during disruptive technological change: The critical role of rate of disengagement. *Journal of Marketing, 86*(1), 149-166. http://dx.doi.org/10.1177/0022242920967912

Chen, S., Lin, L., & Yuan, X. (2017). Social media visual analytics. *Computer Graphics Forum, 36*(3), 563-587. 10.1111/cgf.13211

Choi, J., Oh, S., Yoon, J., Lee, J., & Coh, B. (2020). Identification of time-evolving product opportunities via social media mining. *Technological Forecasting and Social Change, 156*, 1-12. http://dx.doi.org/10.1016/j.techfore.2020.120045

Chohan, R., & Paschen, J. (2021). How marketers can use non-fungible tokens (NFTs) in their campaigns. *Business Horizons,* 1-8. http://dx.doi.org/10.1016/j.bushor.2021.12.004

Chou, S. (2019). The Fourth Industrial Revolution: Digital fusion with Internet of Things. *Journal of International Affairs, 72*(1), 107-120. https://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=134748796&site=ehost-live

Christensen, C. (1997). *The innovator's dilemma: When new technologies cause great firms to fail*. Harvard Business School Press. https://www.hbs.edu/faculty/Pages/item.aspx?num=46

Chu, Z., Gianvecchio, S., Wang, H., & Jajodia, S. (2012). Detecting automation of Twitter accounts: Are you a human, bot, or cyborg? *IEE Transactions on Dependable and Secure Computing, 9*(6), 811-824. 10.1109/TDSC.2012.75

Chursook, A., Yahya Dawod, A., Chanaim, S., Naktnasukanjn, N., & Chakpitak, N. (2022). Twitter sentiment analysis and expert ratings for initial coin offering fundraising: Evidence from Australia and Singapore markets. *TEM Journal*, 44-55. 10.18421/TEM111-06

Cornelius, K. (2021). Betraying blockchain: Accountability, transparency and document standards for non-fungible tokens (NFTs). *Information, 12*(9), 1-17. https://doi.org/10.3390/info12090358

Critien, J.V., Gatt, A., & Ellul, J. (2022). Bitcoin price change and trend prediction through twitter sentiment and data volume. *Financial Innovation, 8*(1), 1-20. 10.1186/s40854-022-00352-7

Curiskis, S. A., Drake, B., Osborn, T. R., & Kennedy, P. J. (2020). An evaluation of document clustering and topic modelling in two online social networks: Twitter and Reddit. *Information Processing & Management, 57*(2), 1-21. 10.1016/j.ipm.2019.04.002

Danneels, E. (2004). Disruptive technology reconsidered: A critique and research agenda. *Journal of Product Innovation Management, 21*(4), 246-258. http://dx.doi.org/10.1111/j.0737-6782.2004.00076.x

Das, S., & Dutta, A. (2021). Characterizing public emotions and sentiments in COVID-19 environment: A case study of India. *Journal of Human Behavior in the Social Environment, 31*(1-4), 154-167. https://doi.org/10.1080/10911359.2020.1781015

Dirchi, R. (2022, February 12). *Hollywood celebrities who have launched NFTs*. https://www.livemint.com/news/world/hollywood-celebrities-who-have-launched-nfts-11644626580528.html

Discord. (2023). *Discord Developer Policy*. https://discord.com/developers/docs/policies-and-agreements/developer-policy

Doorsamy, W., Paul, B.S., Marwala, T. (2020). *The Disruptive Fourth Industrial Revolution: Technology, Society and Beyond*. Springer International Publishing. http://link.springer.com/10.1007/978-3-030-48230-5

Dowling, M. (2022). Fertile LAND: Pricing non-fungible tokens. *Finance Research Letters, 44*, 1-5. https://doi.org/10.1016/j.frl.2021.102096

Draper, N.A., & Turow, J. (2019). The corporate cultivation of digital resignation. *New Media & Society, 21*(8), 1824-1839. https://doi.org/10.1177/1461444819833331

Duffy, C., & Fung, B. (2022, October 10). *Elon Musk commissioned this bot analysis in his fight with Twitter. Now it shows what he could face if he takes over the platform. CNN Business*. https://www.cnn.com/2022/10/10/tech/elon-musk-twitter-bot-analysis-cyabra/index.html#:~:text=Twitter%20has%20for%20years%20said,daily%20active%20users%20(mDAU)

Ethereum. 2023. *Online communities*. https://ethereum.org/en/community/online/

Ferone, A., & Della Porta, A. (2022). A blockchain-based infection tracing and notification system by non-fungible tokens. *Computer Communications, 192*, 66-74. http://dx.doi.org/10.1016/j.comcom.2022.05.027

Folding Ideas. (2022, January 21). *Line goes up – the problem with NFTs*. [Video]. Youtube. https://www.youtube.com/watch?v=YQ_xWvX1n9g

Gartner. (2021). *Gartner identifies key emerging technologies spurring innovation through trust, growth and change*. https://www.gartner.com/en/newsroom/press-releases/2021-08-23-gartner-identifies-key-emerging-technologies-spurring-innovation-through-trust-growth-and-change

Gartner. (2022). *Main page*. https://www.gartner.com/en

Gayvoronskaya, T., & Meinel, C. (2021). *Blockchain: Hype or innovation*. Springer Nature Switzerland. https://doi.org/10.1007/978-3-030-61559-8

Gephi. (2022). *Home Page*. https://gephi.org/

Giachanou, A., & Crestani, F. (2016). Like it or not: A survey of Twitter sentiment analysis methods. *ACM Computing Surveys, 49*(2), 1-41. 10.1145/2938640

Ghani, N., Hamid, S., Targio Hashem, I., & Ahmed, E. (2019). Social media big data analytics: A survey. *Computers in Human Behavior, 101*, 417-428. 10.1016/j.chb.2018.08.039

Grandle. (2022). *What is Grandle?* https://grandle.io/#what-is-grandle

Hamrick, J.T., Rouhi, F., Mukherjee, A., Feder, A., Gandal, N., Moore, T., & Vasek, M. (2021). An examination of the cryptocurrency pump-and-dump ecosystem. *Information Processing & Management, 58*(4), 1-16. https://doi.org/10.1016/j.ipm.2021.102506

Hopster, J. (2021). What are socially disruptive technologies? *Technology in Society, 67*, 1-8. http://dx.doi.org/10.1016/j.techsoc.2021.101750

Horky, F., Rachel, C., & Fidrmuc, J. (2022). Price determinants of non-fungible tokens in the digital art market. *Finance Research Letters, 48*, 1-9. https://doi.org/10.1016/j.frl.2022.103007

Hosseini, B.S., Nasim, N., Omid, B., & Qiang, Q. (2022). Patents and intellectual property assets as non-fungible tokens; key technologies and challenges. *Scientific Reports, 12*(1), 1-14. https://doi.org/10.1038/s41598-022-05920-6

Hu, H., Wen, Y., Chua, T., Huang, J., Zhu, W., & Li, X. (2016). Joint content replication and request routing for social video distribution over cloud CDN: A community clustering method. *IEE Transactions on Circuits and Systems for Video Technology, 26*(7), 1320-1333. 10.1109/TCSVT.2015.2455712

Hughes, A., Park, A., Kietzmann, J., & Archer-Brown, C. (2019). Beyond Bitcoin: What blockchain and distributed ledger technologies mean for firms. *Business Horizons, 62*(3). 273-281. https://doi.org/10.1016/j.bushor.2019.01.002

ICOAnnouncement. (2023). *Main page*. https://icoannouncement.io/

Jeong, B., Yoon, J., & Lee, J. (2019). Social media mining for product planning: A product opportunity mining approach based on topic modeling and sentiment analysis. *International Journal of Information Management, 48*, 280-290. http://dx.doi.org/10.1016/j.ijinfomgt.2017.09.009

Kastrenakes, J. (2021, March 11). *Beeple sold an NFT for $69 million*. https://www.theverge.com/2021/3/11/22325054/beeple-christies-nft-sale-cost-everydays-69-million

Katte, S. (2022, August 16). *Justin Bieber, Paris Hilton among 19 celebs called out for shilling NFTS.* https://cointelegraph.com/news/19-celebrities-called-out-by-consumer-watchdog-group-for-shilling-nfts

Kimani, D., Adams, K., Attah-Boakye, R., Ullah, S., Frecknall-Hughes, J., & Kim, J. (2020). Blockchain, business and the fourth industrial revolution: Whence, whither, wherefore and how? *Technological Forecasting and Social Change, 161*, 1-16. https://doi.org/10.1016/j.techfore.2020.120254

King, D., & Delfabbro, P. (2019). Video game monetization (e.g., 'Loot Boxes'): A blueprint for practical social responsibility measures. *International Journal of Mental Health and Addiction, 17*(1), 166-179. https://doi.org/10.1007/s11469-018-0009-3

King, D., Delfabbro, P., Gainsbury, S., Dreier, M., Greer, N., & Billieux, J. (2019). Unfair play? Video games as exploitative monetized services: An examination of game patents from a consumer protection perspective. *Computers in Human Behaviour, 101*, 131-143. 10.1016/j.chb.2019.07.017

King, D., Russell, A., Delfabbro, P., & Polisena, D. (2020). Fortnite microtransaction spending was associated with peers' purchasing behaviors but not gaming disorder symptoms. *Addictive Behaviors, 104*, 1-7. https://doi.org/10.1016/j.addbeh.2020.106311

Klaytn. (2023). *Klaytn.Foundation.* https://klaytn.foundation/

Ko, H., Son, B., Lee, Y., Jang, H., & Lee, J. (2022). The economic value of NFT: Evidence from a portfolio analysis using mean-variance framework. *Finance Research Letters, 47*, 1-10. 10.1016/j.frl.2022.102784

Kontopoulos, E., Berberidis, C., Dergiades, T., & Bassiliades, N. (2013). Ontology-based sentiment analysis of Twitter posts. *Expert Systems with Applications, 40*(10), 4065-4074. 10.1016/j.eswa.2013.01.001

Kraaijeveld, O., & De Smedt, J. (2020). The predictive power of public Twitter sentiment for forecasting cryptocurrency prices. *Journal of International Financial Markets, Institutions and Money, 65*, 1-22. https://doi.org/10.1016/j.intfin.2020.101188

Kshetri, N. (2022). Scams, frauds, and crimes in the Nonfungible Token market. *Computer, 55*(4), 60-64. 10.1109/MC.2022.3144763

Kugler, L. (2021) Non-fungible tokens and the future of art. *Communications of the ACM, 64*(9), 19-20. https://doi.org/10.1145/3474355

Lansiaux, E., Tchagaspanian, N., & Forget, J. (2022). Community impact on a cryptocurrency: Twitter comparison example between Dogecoin and Litecoin. *Frontiers in Blockchain, 5*, 1-17. http://dx.doi.org/10.3389/fbloc.2022.829865

Li, Y., Goodell, J.W., & Shen, D. (2021). Comparing search-engine and social-media attentions in finance research: Evidence from cryptocurrencies. *International Review of Economics & Finance, 75*, 723-746. 10.1016/j.iref.2021.05.003

Liu, W., Liu, R., Chen, H., & Mboga, J. (2020). Perspectives on disruptive technology and innovation: Exploring conflicts, characteristics in emerging economies. *International Journal of Conflict Management, 31*(3), 313-331. http://dx.doi.org/10.1108/IJCMA-09-2019-0172

Luhmann, J., & Burghardt, M. (2022). Digital humanities—A discipline in its own right? An analysis of the role and position of digital humanities in the academic landscape. *Journal of the Association for Information Science and Technology, 73*(2), 148-171. 10.1002/asi.24533

Mackenzie, S., & Bērziņa, D. (2021). NFTs: Digital things and their criminal lives. *Crime, Media, Culture*, 1-16. https://doi.org/10.1177/17416590211039797

Mahmood, T., & Mubarik, M.S. (2020). Balancing innovation and exploitation in the fourth industrial revolution: Role of intellectual capital and technology absorptive capacity. *Technological Forecasting and Social Change, 160*, 1-9. http://dx.doi.org/10.1016/j.techfore.2020.120248

Martinelli, A., Mina, A., & Moggi, M. (2021). The enabling technologies of industry 4.0: Examining the seeds of the fourth industrial revolution. *Industrial and Corporate Change, 30*(1), 161-188. https://doi.org/10.1093/icc/dtaa060

Martinez-Camara, E., Martin-Valdivia, M. T., Urena-Lopez, L. A., & Montejo-Raez, A. (2012). Sentiment analysis in Twitter. *Natural Language Engineering, 20*(1), 1-28. 10.1017/S1351324912000332

Mohammad, S. (2011). *NRC Word-Emotion Association Lexicon (aka EmoLex)*. https://saifmohammad.com/WebPages/NRC-Emotion-Lexicon.htm#:~:text=NRC%20Word%2DEmotion%20Association%20Lexicon,were%20manually%20done%20by%20crowdsourcing.

Mohammad, S., & Turney, P. (2013). Crowdsourcing a word-emotion association lexicon. *Computational Intelligence, 29*(3), 436-465. https://doi-org.ezproxy.library.dal.ca/10.1111/j.1467-8640.2012.00460.x

Morrow, M.J., & Zarrebini, M. (2019). Blockchain and the tokenization of the individual: Societal implications. *Future Internet, 11*(10), 1-12. http://dx.doi.org/10.3390/fi11100220

Naeem, M.A., Mbarki, I., & Shahzad, S. (2021). Predictive role of online investor sentiment for cryptocurrency market: Evidence from happiness and fears. *International Review of Economics & Finance, 73*, 496-514. 10.1016/j.iref.2021.01.008

Naeem, M.A., Mbarki, I., Suleman, M.T., Vo, X.V., & Shahzad, S.J.H. (2021). Does Twitter happiness sentiment predict cryptocurrency? *International Review of Finance, 21*(4), 1529-1538. https://doi.org/10.1111/irfi.12339

Neely, E. (2021). Come for the game, stay for the cash grab: The ethics of loot boxes, microtransactions, and freemium games. *Games and Culture, 16*(2), 228-247. https://doi.org/10.1177/1555412019887658

Ngo, V. M. (2022). Dataset of discourses about COVID-19 and financial markets from Twitter. *Data in Brief, 43*, 1-10. 10.1016/j.dib.2022.108428

Nielsen, F. (2011). A new ANEW: Evaluation of a word list for sentiment analysis in microblogs. *Proceedings of the ESWC2011*, 93-98. https://doi.org/10.48550/arXiv.1103.2903

Nizzoli, L., Tardelli, S., Avvenuti, M., Cresci, S., Tesconi, M., & Ferrara, E. (2020). Charting the landscape of online cryptocurrency manipulation. *IEEE Access, 8*, 113230-113245. https://doi.org/10.1109/ACCESS.2020.3003370

O'Dwyer, R. (2020). Limited edition: Producing artificial scarcity for digital art on the blockchain and its implications for the cultural industries. *Convergence: The International Journal of Research into New Media Technologies, 25*(4), 874-894. https://doi.org/10.1177/1354856518795097

Palmié, M., Wincent, J., Parida, V., & Caglar, U. (2020). The evolution of the financial technology ecosystem: An introduction and agenda for future research on disruptive innovations in ecosystems. *Technological Forecasting and Social Change, 151*, 1-10. https://doi.org/10.1016/j.techfore.2019.119779

Park, H.W., & Lee, Y. (2019). How are twitter activities related to top cryptocurrencies' performance? Evidence from social media network and sentiment analysis. *Drustvena Istrazivanja, 28*(3), 435-460. https://doi.org/10.5559/di.28.3.04

Patrickson, B. (2021). What do blockchain technologies imply for digital creative industries? *Creativity and Innovation, 30*(3), 585-595. https://doi.org/10.1111/caim.12456

Pinto-Gutiérrez, C., Gaitán, S., Jaramillo, D., & Velasquez, S. (2022). The NFT hype: What draws attention to Non-Fungible Tokens? *Mathematics, 10*(3), 1-13. https://doi.org/10.3390/math10030335

Porwol, L., Ojo, A., & Breslin, J.G. (2018). Social software infrastructure for e-participation. *Government Information Quarterly, 35*(4), 88-98. https://doi.org/10.1016/j.giq.2016.01.002

Postelnicu, C., & Calea, S. (2019). The Fourth Industrial Revolution. Global risks, local challenges for employment. *Montenegrin Journal of Economics, 15*(2), 195-206. https://doi.org/10.14254/1800-5845/2019.15-2.15

Powell, F. (2022, December 13). *FTX ex-Ceo Sam Bankman-Fried is arrested*. https://www.forbes.com/advisor/investing/cryptocurrency/what-happened-to-ftx/

QLIP. (2023). *Main Page*. https://qlipit.io/

Ramirez, D. (2023, January 10). *FTX crash: Timeline, fallout and what investors should know*. https://www.nerdwallet.com/article/investing/ftx-crash

Redman, J. (2022, May 14). *Crypto market rout pulls the floor out from blue-chip NFTS, weekly sales down 64%*. https://news.bitcoin.com/crypto-market-rout-pulls-the-floor-out-from-blue-chip-nfts-weekly-sales-down-64/

Roth, E. (2022, May 16). *Spotify experiments with musician NFT galleries*. https://www.theverge.com/2022/5/16/23074909/spotify-experiments-musician-nft-galleries

Sailunaz, K., & Alhajj, R. (2019). Emotion and sentiment analysis from Twitter text. *Journal of Computational Science, 36*, 1-18. 10.1016/j.jocs.2019.05.009

Saltzman, M. (2017). Social media mining: Can we prevent the apocalypse? *Journal of Biosecurity, Biosafety and Biodefense Law, 8*, 19-38. https://heinonline.org/HOL/P?h=hein.journals/jbbl8&i=23

Sang, X., Leng, X., Xue, L., & Ran, X. (2022). Based on the time-spatial power-based cryptocurrency miner driving force model, establish a global CO2 emission prediction framework after China bans cryptocurrency. *Sustainability, 14*(9), 1-19. https://doi.org/10.3390/su14095332

Sarkar, A. (2022, February 5). *Indian couple celebrates blockchain wedding with NFT vows, digital priest*. https://cointelegraph.com/news/indian-couple-celebrates-blockchain-wedding-with-nft-vows-digital-priest

Saura, J.R., Palacios-Marqués, D., & Ribeiro-Soriano, D. Exploring the boundaries of open innovation: Evidence from social media mining. *Technovation*, 1-13. https://doi.org/10.1016/j.technovation.2021.102447

Schuelke-Leech, B. (2018). A model for understanding the orders of magnitude of disruptive technologies. *Technological Forecasting and Social Change, 129*, 261-274. https://doi.org/10.1016/j.techfore.2017.09.033

Schwab, K. (2017). The Fourth Industrial Revolution: Its meaning and how to respond. *Logistics & Transport Focus, 19*(2), 40-41. https://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=121034925&site=ehost-live

Shahzad, S., Anas, M., & Bouri, E. (2022). Price explosiveness in cryptocurrencies and Elon Musk's tweets. *Finance Research Letters, 47*, 1-11. 10.1016/j.frl.2022.102695

Silge, J., & Robinson, D. (2022). 2. Sentiment analysis with tidy data. https://www.tidytextmining.com/sentiment.html Soussan, T., & Trovati, M. (2020). Sentiment urgency emotion conversion over time for business intelligence. *International Journal of Web Information Systems, 16*(5), 519-528. http://dx.doi.org/10.1108/IJWIS-08-2020-0049

Starinsky, S. (2021). From books to Facebook: How social media became the biggest publisher of our time. *Publishing Research Quarterly, 37*(4), 657-670. https://doi.org/10.1007/s12109-021-09835-4

Stevens, R. (2022, February 9). *Sports NFTs: How to get in the game*. https://www.coindesk.com/learn/sports-nfts-how-to-get-in-the-game/

Tang, A., Lee, P., Lam, S., Siu, S., Ye, C., & Lee, R. (2022). Prediction of problem gambling by demographics, gaming behavior and psychological correlates among gacha gamers: A cross-sectional online survey in Chinese young adults. *Frontiers in Psychiatry, 13*, 1-12. 10.3389/fpsyt.2022.940281

Tassi, P. (2022, May 13). *Square Enix details its elaborate NFT plans as the market craters*. https://www.forbes.com/sites/paultassi/2022/05/13/square-enix-details-its-elaborate-nft-plans-as-the-market-craters/?sh=604d1791feb3

Tandon, C., Revankar, S., Palivela, H., & Parihar, S. S. (2021). How can we predict the impact of the social media messages on the value of cryptocurrency? Insights from big data analytics. *International Journal of Information Management Data Insights, 1*(2), 1-8. 10.1016/j.jjimei.2021.100035

Tezos. (2023). *Main Page*. https://tezos.com/

Truby, J., Brown, R.D., Dahdal, A., & Ibrahim, I. (2022). Blockchain, climate damage, and death: Policy interventions to reduce the carbon emissions, mortality, and net-zero implications of non-fungible tokens and Bitcoin. *Energy Research & Social Science, 88*, 1-14. https://doi.org/10.1016/j.erss.2022.102499

Ullah, F., & Lee, S. (2017). Community clustering based on trust modeling weighted by user interests in online social networks. *Chaos, Solitons & Fractals, 103*, 194-204. 10.1016/j.chaos.2017.05.041

Umar, M., Rizvi, S.K.A., & Naqvi, B. (2021). Dance with the devil? The nexus of fourth industrial revolution, technological financial products and volatility spillovers in global financial systems. *Technological Forecasting and Social Change, 163*, 1-11. http://dx.doi.org/10.1016/j.techfore.2020.120450

United States Attorney's Office. (2023, January 5). *Non-Fungible Token (NFT) Developer Charged in Multi-Million Dollar International Fraud Scheme*. https://www.justice.gov/usao-edny/pr/non-fungible-token-nft-developer-charged-multi-million-dollar-international-fraud

Valeonti, F., Bikakis, A., Terras, M., Speed, C., Hudson-Smith, A., Chalkias, K. (2021). Crypto collectibles, museum funding and openGLAM: Challenges, opportunities and the potential of non-fungible tokens (NFTs). *Applied Sciences, 11*(21), 1-20. http://dx.doi.org/10.3390/app11219931

Whitaker, A. (2018). Artist as owner not guarantor: The art market from the artist's point of view. *Visual Resources, 34*(1-2), 48-64. https://doi.org/10.1080/01973762.2018.1435609

Wischnewski, M., Ngo, T., Bernemann, R., Jansen, M., & Kramer, N. (2022). "I agree with you, bot!" How users (dis)engage with social bots of Twitter. *New Media & Society*, 1-22. https://doi.org/10.1177/14614448211072307

Xiao, L., & Henderson, L. (2021). Towards an ethical game design solution to loot boxes: A commentary on King and Delfabbro. *International Journal of Mental Health and Addiction, 19*(1), 177-192. https://doi.org/10.1007/s11469-019-00164-4

Ye, J. (2022, May 4). *Shanghai residents turn to NFTs to record COVID lockdown, combat censorship*. https://www.reuters.com/technology/shanghai-residents-turn-nfts-record-covid-lockdown-combat-censorship-2022-05-04/

Yin, H., Cui, B., Chen, L., Hu, Z., & Zhou, X. (2015). Dynamic user modeling in social media systems. *ACM Transactions on Information Systems, 33*(3), 1-44. https://doi.org/10.1145/2699670

Zeilinger, M. (2018). Digital Art as 'Monetised Graphics': Enforcing Intellectual Property on the Blockchain. *Philosophy and Technology, 31*(1), 15-41. https://doi.org/10.1007/s13347-016-0243-1

Zendle, D., Meyer, R., & Ballou, N. (2020). The changing face of desktop video game monetisation: An exploration of exposure to loot boxes, pay to win, and cosmetic microtransactions in the most-played Steam games of 2010-2019. *PLOS ONE, 15*(5), 1-13. 10.1371/journal.pone.0232780

Zou, H., Chen, H.M., & Dey, S. (2015). Exploring user engagement strategies and their impacts with social media mining: The case of public libraries. Journal of *Management Analytics, 2*(4), 295-313. https://doi.org/10.1080/23270012.2015.1100969

Zubiaga, A., Heravi, B., An, J., & Kwak, H. (2019). Social media mining for journalism. *Online Information Review, 43*(1), 2-6. https://doi.org/10.1108/OIR-02-2019-395