Twitch Plays Pokémon: An Exploratory Analysis of Crowd Collaboration

ABSTRACT

Twitch Plays Pokémon Red was a crowd-driven social phenomenon where users collectively controlled a single game character by typing commands in the game chat room. Sixteen days of continuous gameplay attracted a total of 55 million views [37] and more than 750,000 participants. We illustrate the importance of imposed process rules on synchronous crowd platforms and present results supporting the mean voter theorem. We group participants based on their voting behavior during the game and present key differences identified, such as voting intensity, words used, voting participation and game participation. The analysis of 67,566 voting sequences yielded four main clusters of voting patterns. Implications for massive synchronous crowd collaborations are discussed.

Author Keywords

Synchronous Interaction; Organizational Design; Crowd Collaboration; Web-based Interaction; Games; Crowdsourcing.

ACM Classification Keywords

H.5.3 [Information Interfaces and Presentation]: Collaborative Computing.

General Terms

Human Factors; Theory; Design.

INTRODUCTION

Twitch is a live streaming video platform that allows users to broadcast their gameplay or watch others play. Emulator-based video platforms have been the focal point of CSCW researchers in the past [33]. In February 2014, an anonymous Australian programmer launched the game Twitch Plays Pokémon (TPP) consisting of an IRC bot and a Game Boy emulator (Figure 1). The webpage hosting it quickly went viral, attracting more than 55 million views. This analysis is based on 16.2 million chat lines from 750,167 unique users that participated in the game over the course of 16 days of continuous gameplay.

The game was designed so that participants were allowed to vote to set the overall game play into an anarchy or a democracy mode as well as control the game through the channel's IRC chat. In anarchy mode, all commands submitted by any user would be used in the order they were received. In democracy mode a majority poll would be taken over a period of time[1] to decide what should be done next.

Figure 1. Players Simultaneously Control a Game Session of Pokémon Red (Left Side) by Submitting Commands at the Chat Room of the Game (Right Side).

Thus, votes were taken to determine the mode in which the game would be played in. And, if the mode selected was democracy, there were votes taken to decide the next move. This game, then, with over 750,000 users focused on making thousands of decisions that would eventually drive a single action, may provide data that can shed light on computer supported cooperative work.

Or not. The phenomenon had several unique characteristics that may not generalize to other collective decision making environments. In particular, the high number of users created long lags, which were described as annoyances. On the other hand, despite these annoyances, many players interacted with the game. Commentary from the game itself, and from outside observers, provides some insight into the thinking that pervaded play.

Some were playing to win the game, while others were playing the game for different reasons, functioning as trolls in order to increase, perhaps, the entertainment value of the entire experience. A small fraction was in fact playing an entirely different game: inputs were being funneled into a Tetris game: Twitch Plays Pokemon Plays Tetris [9,38].

Moreover, quickly many people began identifying with either the democracy mode or the anarchy mode. From an objective perspective, each mode has different advantages and disadvantages. Democracy should be good for picking the proper move through the wisdom of the crowd. Indeed, early studies on group decision making showed that, in

[1] The voting poll was usually taken every 30 seconds.

traversing a maze, the modal answer of a group is nearly always correct [22], and later studies have reinforced this finding [23]. This is perhaps because random errors cancel each other out, and those who remember what to do reinforce each other's signals. Video games such as Pokemon are very similar to mazes. However, voting for each move in a maze takes time. In the configuration studied, each vote took 30 seconds. As one person observed, this meant that most of the time was spent looking at a non-moving screen.

	Population	Discussion Participation	Game Participation
Anarchists	13.87%	16.76%	21.78%
Democrats	27.41%	28.45%	29.98%
Voted For Both	9.15%	33.34%	34.32%
Did Not Vote	50.42%	21.46%	13.92%
Total	750,167	3,098,317	13,047,632

Table 1. Summary Statistics of Population, Discussion Participation and Game Participation of People that Voted for Anarchy, Democracy, Both or Neither.

By contrast, Anarchy allows for faster, more exciting play. If the task is simple, and the players are dedicated toward accomplishing the task, then Anarchy should work well. But if a task is complex, and the players who happen to move first don't know the right moves, then their exploration may essentially be random. Moreover, if some participants wish to sabotage game play, this is easier to do in Anarchy mode.

An optimal strategy might emerge in the absence of trolls. In the presence of trolls, such a result would be unlikely (see Table 6). Indeed, the game was far from optimal in completion time, but arguably was high on entertainment value, judging from the number of participants.

In the following sections, we explore what happened in the game. Researchers have argued that collective action may be difficult to achieve [11] and have wondered about what happens as the size of the crowd increases [20]. We focus on the behavior of people that were in favor of each of the two modes and discuss the learnings and implications for future crowd collaboration platforms. Starting with a review of the CSCW literature on character sharing and synchronous collaboration, we present findings that illustrate the importance of process rules even in massive crowdsourcing endeavors. Building upon political science theory we focus on the voting behavior of the participants and test the mean voter theorem [6]. We conclude with implications of our findings for both CSCW and organizational science.

CHARACTER SHARING

Multiplayer games were created by Essex University students in 1979 [19] and have been used to observe group dynamics [11]. Character sharing in multiplayer and online games is a little known form of collaboration despite its wide use [34]. One of the main reasons it has not been openly discussed is that it has been prohibited in several platforms (e.g. World of Warcraft) [34]. Wong et al. (2009) found that 64% of the players had shared (57%) or were willing to share (7%) their character despite the imposed prohibition [34].

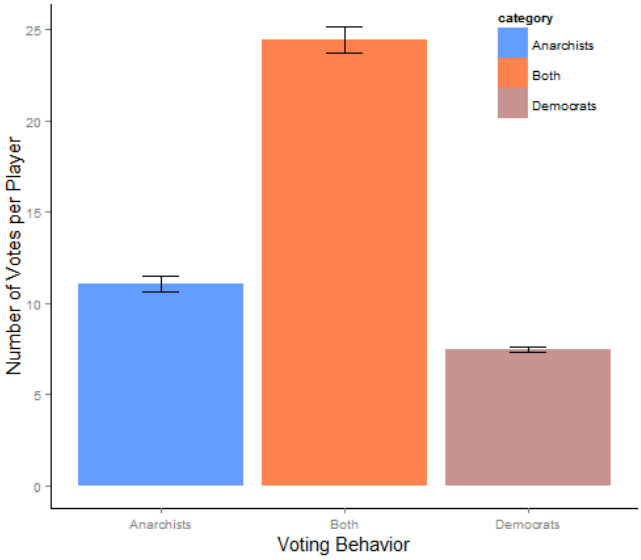

Figure 2. Number of Votes of People that Voted for Anarchy, Democracy, or Both. Pairwise Comparisons using t-tests with pooled SD and Holm adjustment method. All p-values <0.0001.

Organizations of players in online games provide an opportunity to understand how crowd systems can be improved while increasing the quality of work produced and the experience of the participants[20]. Guilds in World of Warcraft (WoW) are usually long-term in-game associations of multiple game characters organized by players [11]. They range in size from a small handful, to a couple of hundred players. Another form of organization in WoW are raids which typically include 6-40 users who group to achieve an in-game objective [34]. Previous studies have focused on motivations and player demographics [35], concerns [34], collaboration [10,28,33,34] and the impact of friendship on collaborative and competitive performance [26].

SYNCHRONOUS COLLABORATION

Many tasks that could benefit from crowdsourcing require cooperation – yet crowdsourcing has largely focused on independent work [20]. Scholars have developed platforms [33] to support real-time distributed collaboration including collaborative text authoring software [21]. These techniques draw on synchronous collaboration research [16,17].

Hierarchy in such environments might improve coordination and decision making, but it may also cause

resistance [20]. Malone & Crowston (1994) suggested a number of examples of task allocation mechanisms, ranging from first come/first serve, to markets and managerial decisions [25]. For instance in WoW, growing a guild while portioning the members into small, balanced subgroups appeared to be effective [11].

Twitch plays Pokémon revealed some of the issues that massive and flash crowds may face while trying to perform synchronously [20]. The participants completed the game after 16 days of continuous gameplay, while an average user would have completed a Pokémon Red game in 30 hours [39]. Thus, if the main idea of collective projects is that the joint effort of many actors leads to a better outcome than any actor could achieve individually [18], Twitch Plays Pokémon is a dramatic failure.

But Twitch Plays Pokémon managed to assemble the largest collaborative crowd to date without providing any monetary compensation. In addition, TPP managed to retain the interest of its users for more than two weeks. TPP participants self-organized to overcome issues caused by the unprecedented success of the game. They created scripts that would hide game input commands from the chat window so they could communicate, created a Reddit stream that attracted about 10% of the game's traffic to help them keep up to date with the game and collectively compiled a 190 pages long report including all major TPP events and achievements.

DATA

We collected the text chat portion of the game initially through an IRC client [7] and later through a console client to external text files. These scripts included all commands sent to the game and player communication. Our dataset is nearly complete as it includes about 98.7% of all game time in TPP[2]. Our analysis also included data collected from tech news and blogs through snowball sampling method [31], Reddit subcommunities, Wikipedia entries and crowd driven progress report pages.

VOTING BEHAVIOR

We classified users in three categories: (i) people that voted only for democracy throughout the game (democrats), (ii) people that voted only for anarchy (anarchists) and (iii) people that voted at least once for both regimes (independents). As can be seen in Figure 2, an average anarchist voted 49% more than an average democrat (μ=8.17 votes). Independents submitted on average more than two times more votes than anarchists.

MEAN VOTER THEOREM

In TPP, 166,912 unique users voted at least once for anarchy and 266,281 unique users voted at least once from democracy. Most of the game was spent in anarchy mode due to the process rules. In addition, 68,628 people voted for both democracy and anarchy at least once during the game (Table 1).

According to the median voter theorem, a majority rule voting system will select the outcome most preferred by the median voter. An implication of the theorem is that votes of people that are closer to the center of a one-dimensional political spectrum are more important. To test the mean voter theorem, we looked at 37,805 people that voted exactly three times. We expected that if the median voter theorem holds in this environment, then votes of people that are willing to swing their votes would be able to predict the final outcome. Among these people, we found 39,789 anarchy votes and 73,626 democracy votes. Democracy, received 64,145 (56.56%) of the votes. When looking only at the people that were willing to vote for both sides, the result was replicated (60.16% democracy votes), supporting the mean voter theorem.

To confirm our findings, we looked at all votes submitted at TPP over the course of 16 days, leading to a total of 2,071,234 anarchy votes and 2,284,061 democracy votes. After filtering users that voted excessively[3], the result was replicated. Users that had voted for both democracy and anarchy (n=68,628) contributed 556,367 democracy and 370,223 anarchy votes, hence supporting the mean voter theory. This suggests that anarchists and democrats are behaving like political parties.

THE IMPORTANCE OF PROCESS RULES

Synchronous collaboration systems should articulate a vision for crowd work that is effective, efficient and fair [20]. Most of the tension in TPP was caused due to the implementation of anarchy (where democrats would complain about the randomness of the game) and democracy (where anarchists would complain about the slow speed, and some would organize themselves to sabotage the game by arbitrarily pressing buttons or pausing the game). This political division, it must be remembered, was entirely created through the process rules.

We analyzed the mode voting process rules of Twitch Plays Pokémon. Users could decide between anarchy mode where all commands submitted by any user would be implemented and democracy mode where the majority chose the next command. The game required 50% anarchy votes to switch

[2] We were not able to collect data during the second game day for about 5 hours.

[3] We deleted top 1% of voters based on the frequency of their votes. The minimum voting frequency of a deleted user was n=286 and maximum n=14,470. In total, 687 voters were not included.

to anarchy mode, whereas democracy would prevail if at least 80% of the people voted in favor of it[4].

Voters / Topic	Democrats
Anarchy	• "i think that anarchists are lonely because no one will be their friend so they just spend all their time on the computer. that's why they don't care when anarchy takes 12 hours to accomplish what democracy could do in 1 hour. they literally have nothing better to do and they consider this event as one of their greatest life achievements despite contributing less than .001%." • "this game shows why anarchy is utopic" • "voting for anarchy or democracy is in itself democracy! democracy wins by default" • "bird jesus is *** cancer. omaster is *** cancer. you are all cancer. die in a bailing machine ***. anarchy is *** cancer. only democracy. " • "the chaos of anarchy costs another victory."
Democracy	• “guys, this is our dream: democracy!” • “this never would of happened with democracy “ • “jeez guys we need democracy to beat that guy so go” • “if we ever want to get out of this tower we will have to do democracy” • “this is an accurate portrayal of how democracy works.” • “we need democracy for this part”

Table 2. Selected Quotes from Democrats Commenting on Anarchy and Democracy.

TEXT ANALYSIS

From the data collected, we deleted all lines that included solely Twitch plays Pokémon game commands and stop words[5]. Next we looked at the words most often used by democrats (Figure 7), anarchists (Figure 8) and independent users. Table 3 shows the ten most commonly used words after controlling for their population. The first column shows the most commonly used words that anarchists used compared to the words that democrats used and vice versa for the second column. In addition, we qualitatively examined quotes from democrats (Table 2) and anarchists (Table 4) commenting on anarchy, democracy and trolls (Table 6).

	Anarchists	Democrats
1	helix	surf
2	riot	need
3	we	stop
4	kappa	vote
5	fossil	spam
6	eevee	pokemon
7	select	plan
8	swiftrage	heal
9	save	zapdos
10	back	gastly

Table 3. Words Mostly Used within Each Group After Controlling for Group’s Population & the Occurrence of the Word in Opposing User Group.

SEQUENCE ANALYSIS

For the voting sequence analysis we used an open source R library [14]. We looked at the first 10 votes of 67,566 people over the course of two weeks and identified 622 unique combinations among them.

Next, we calculated the transition rates across 67,566 players that voted at least ten times (Table 5). Among these users, 25% had voted at least one vote for both “regimes”. As can be seen in Table 5, people voting for anarchy were 2.7 times more likely to sway their vote among all users and 1.6 times more likely among users that were willing to vote for both anarchy and democracy.

In Figure 3, an example of voting subsequences of individuals with stacked bars depicting the statuses over time is illustrated [5,30]. As an example, voter 1 initially voted in favor of anarchy mode and then started supporting democracy mode.

Figure 4 shows the distribution of the ten most common voting sequences among people that voted for both anarchy and democracy. These sequences account for 44% of all sequences observed in the dataset. The most common pattern observed was voting for anarchy in the very first vote and then supporting democracy. This combination was 2.2 times more often than the second most common pattern and accounted for 15.4% of all sequences. Figure 5 shows

[4] The percentage required to switch from democracy mode to anarchy mode was changed by the designer over the course of the game.

[5] Game commands included words like up, down, a, b, anarchy, democracy, start etc. The stop words used were found in the R text mining (tm) package [13].

the most frequent subsequences among the aforementioned users. Once again, switching from anarchy to democracy seemed to be the most common pattern observed.

Voters / Topic	Anarchists
Anarchy	• "we caught zapdos, using the masterball in the power plant. in anarchy mode. it was god**** glorious" • "anarchy is the only way you casuals" • "if you are a filthy heathen, vote democracy! if you are a normal, well adjusted individual (such as myself), vote anarchy" • "our god is with us, along with his twin sons, the sons of anarchy" • "slow mode + lag = auto anarchy. democracy is pointless."
Democracy	• "if you want to make progress then why would you watch tpp? if you guys were watching when it started out you'd realize that anarchy has made all the progress. how can you be proud of achievements in democracy?" • "styla: democracy is for emergencies only, and that's by design. it's why 80% is needed for demo and not just a majority." • "@haplesss: democracy isn't too too bad actually. as an anarchist, i learned that tonight." • "@no_celery: hmm... i'm still an anarchist at heart, so i don't want democracy to teach fonz strength. :3" • "good job democracy, you took the easy way out, because who needs patience when you can ruin the game?" • "guys, chill out. this puzzle is basically what democracy is for. don't be brats about letting them have their turn."

Table 4. Selected Quotes from Anarchists Commenting on Anarchy and Democracy.

Clustering Voting Sequences

Using string edit distances, in terms of insertions, deletions and substitutions, for transforming one sequence into another [1,14,24], we calculated the distance between voting patterns across 17,400 players. Then, we used hierarchical clustering to group all users that were willing to vote for both anarchy and democracy mode. Figure 6 shows four clusters of voting behavior that represent the entire player population.

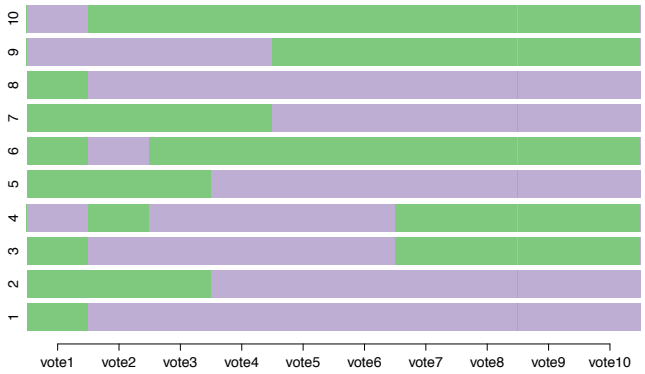

Figure 3. Example of Voting Subsequences Among 10 Players in Twitch. Purple Colored Tiles Indicate a Democracy Vote and Green Tile Indicate an Anarchy Vote.

People in cluster 1 were almost evenly distributed in their first vote between anarchy (green) and democracy (grey) and quickly decided in favor of democracy mode. Cluster 2 includes people that were heavily in favor of anarchy in their first three votes and switched to democracy. Cluster 3 includes primarily players that were heavily in favor of democracy until their 4th vote and then almost collectively switch to anarchy. Finally, cluster 4 includes people that were evenly distributed in their first vote between anarchy and democracy and quickly decided in favor of anarchy, a behavior converse to the one observed in the first cluster.

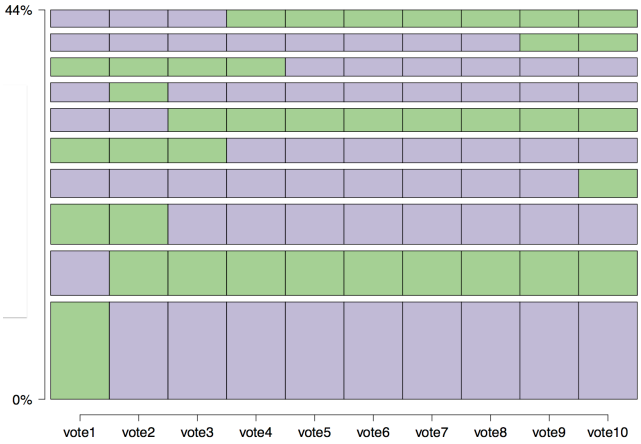

Figure 4. Most Common Voting Sequences Among Independent Users.

ISSUES OBSERVED

Network Lag

The number of people that tried to coordinate was far above the capabilities of the platform [19]. To put it into perspective, viewers (not participants) in a similar platform to Twitch (ArcOnline), would spike to around a thousand viewers when an important game was played and the largest guild observed by Ducheneaut was 257 members [11]. The peak of simultaneous viewership in TPP was 121,000 users [37].

Techniques have been developed that recruit synchronous crowds (on demand, real-time crowdsourcing) in a couple of seconds in an effort to decrease crowd latency [3].

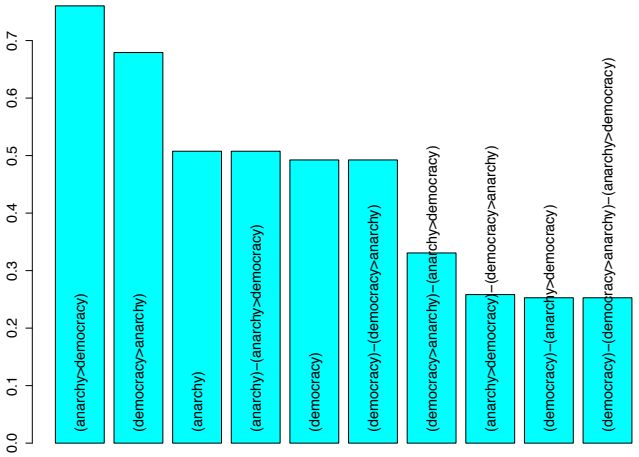

Figure 5. Frequent Voting Subsequences Among People Willing to Vote for Both Anarchy and Democracy.

Network lag [29] was a huge issue while trying to allow 120,000 users to simultaneously control a single character. Network lag was calculated at around 30 seconds between the command submission and its implementation when around 60,000 people where playing together. The rate at which commands were submitted made the game almost impossible to follow for a single individual, creating an environment perhaps appropriate to test the infinite monkey theorem [36] which was the initial intention of the game creator.

All Voters

	Anarchy	Democracy
Anarchy ➔	0.92	0.08
Democracy ➔	0.03	0.97

Voters Willing to Support Both Regimes

	Anarchy	Democracy
Anarchy ➔	0.76	0.24
Democracy ➔	0.15	0.85

Table 5. Transition Rates Between Voting States for 67,566 Users.

Sustainability

In ArcOnline, nearly half of the audience would disappear as soon as an important game was over [33]. In Twitch, the post Twitch Plays Pokémon era was similar. Even though the creator has made sequel Pokémon games available to the community, the viewership is only a fraction of what TPP attracted (although still significant).

CONCLUSION

Twitch Plays Pokémon went viral. In an environment were people were used to watching star players as they play, an open invitation to participate was attractive. TPP success is in line with research arguing that social interaction is a primary driving force for gamers to continue playing [8] and that systems enabling friendship effects may lead to collaboration improvements [26].

Players in other game platforms have indicated that their willingness to share was primarily driven by their desire to experience the game more fully [34].

Small groups of players may learn how to achieve goals through collaborative improvements on communication and coordination [7]. It has been suggested that participation cues may help to understand how users were able to plan and execute collaborative actions [19]. Twitch players self-organized as well: The game was played for 16 consecutive days, during which the crowd built and maintained an achievements page, a live feed webpage and IRC groups to discuss and organize their voting patterns.

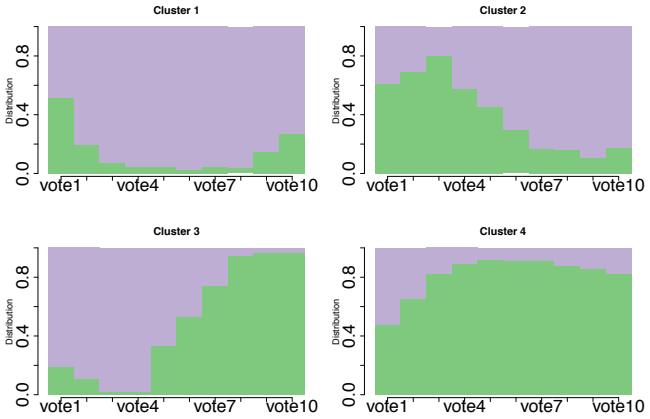

Figure 6. Clusters of People Voting for Both Anarchy and Democracy.

Future Work

Scholars have found that players identify strongly with their characters and consider them to be extensions of themselves [4,32,34]. It would be interesting to test if such a finding persists in synchronous character sharing environments. Also, a cognitive limit to the number of individuals with whom any one person can maintain stable relationships may exist [11,12]. The cognitive limit has been defined alternatively as 35 [11], 50 [2] or 150 [12] people. If true, the number of people simultaneously controlling a game is likely to affect how the player perceives the character (controlled by two people vs. controlled by hundreds). In addition, the percentage of people that consider their characters as extensions of themselves, as valued possessions and as throwaway objects may also be altered in such collaborative environments [34].

Topic / Voters	Trolls
Anarchists	• "your getting democracy with spammers. i thought you guys would be better than a bunch of trolls. " • "dont vote democracy! the trolls will use it to release!" • "luckily there arent enough democracy trolls to screw wiith us tonight. we can get stuff done for once. " • "you would think after 13 days the start trolls would have got bored. oh yeh, most start spammers are 12 and got here on day 9" • "it's funny that you call us trolls when we have the good grace to let you get in, and only started anarchy back up after." • "people....stop spamming down. the idiots and trolls will do that for us. everybody shoot for either left or up when we get next to the gym"
Democrats	• "anarchists are trolls" • "to all the trolls, you are all *** pathetic, i hope you all get your collective genitalia dipped in acid and the wounds salted, you make me want to not live on this *** planet anymore, please do us all a favor and hang yourselves. *** you all." • "anarchy loses to trolls, democracy loses to dum" • "trolls are the only ones with the patience to be doing this non-stop every hour on the hour" • "i see the trolls are out of high school today." • "*** you trolls! you'll never win!! we already got 6 badges with you *** whipes trying to ruin everything!"

Table 6. Selected Quotes from Anarchists and Democrats Commenting on Trolls.

Systems extracting information about collaborations from unstructured databases may reveal structures that will aid the planning of collaborative research [15,27]. In addition, massive crowds are also likely to benefit from the use of systems that would assemble guilds of crowds and AI systems [20].

For synchronous coordination platforms that attract a massive number of players, the answer may lie in a hybrid model of democracy and anarchy. Such a model could combine the crowd wisdom by taking a poll about the next optimal action (democracy element) in a much faster way, or, alternatively, could elect representatives to quickly move through less critical parts of the game terrain. A variant of these ideas called Lottocracy was briefly implemented in one of the Twitch Plays Pokémon sequels and it would be interesting to see its impact on crowd efficiency.

The future of crowdwork will more likely involve myriads of people [20] and Twitch Plays Pokémon has provided a preview of the opportunities and the issues that await.

Figure 7. Word Cloud of Users that Voted only for Democracy.

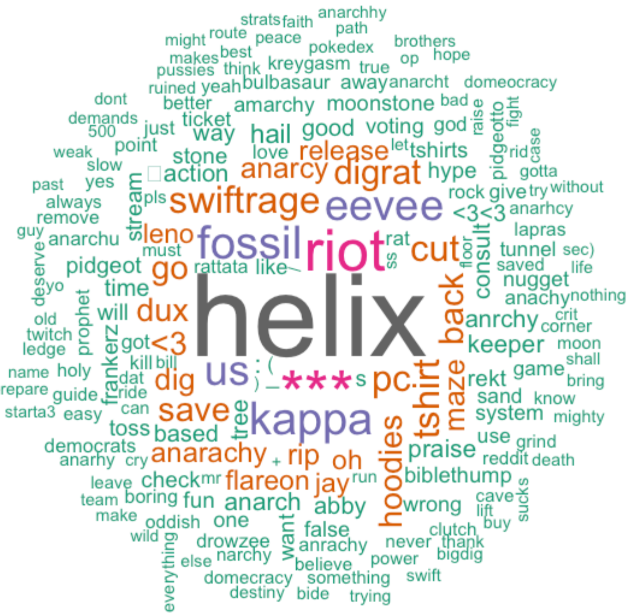

Figure 8. Word Cloud of Users that Voted only for Anarchy.

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