

SMAT: The Social Media Analysis Toolkit

Emmi Bevensee¹, Maxwell Aliapoulos², Quinn Dougherty³,
Jason Baumgartner⁴, Damon McCoy², Jeremy Blackburn⁵

¹University of Arizona, ²New York University, ³Lambda School, ⁴Pushshift, ⁵Binghamton University
emmibevensee@email.arizona.edu, {maliapoulos,mccoy}@nyu.edu, quinnndougherty92@gmail.com,
jason@pushshift.io, jblackbu@binghamton.edu

Abstract

The emergence and near ubiquity of the misuse of social media platforms poses a variety of problems for the research community. One of the primary challenges is dealing with the volume and complexity of analyzing social media across multiple platforms, especially for researchers without computer science backgrounds. In this paper, we present SMAT, a hosted Web application that enables easy exploratory analysis across billions of social media posts. SMAT provides a middleware for Pushshift’s back end data store that performs useful, but complicated aggregations and exports the results to an interactive analysis front end. This front end provides an easy, user friendly interface that enables fast, large scale exploratory analysis that can be deployed on cheap (or even free) cloud resources. In addition to presenting SMAT’s architecture and functionality, we also demonstrate its usefulness via two use cases relevant to the research community focused on emergent dangerous social media phenomena. First, we show how SMAT can be used to help understand shifts in dis- and mis-information campaigns related to Syrian chemical weapons usage. Next, we explore how a decade old conspiracy theory has seen a resurgence in relation to the COVID-19 pandemic.

1 Introduction

The Social Media Analysis Toolkit (SMAT)¹ is designed to facilitate greater access of social-media data analysis tools to a wider audience of non-programmers. Additionally, it is built as a data pipeline that enables developers to build more tools with more data sources. These types of tools are more important than ever as the scale of disinformation and hatred online grows. With more accessible tools, more people can contribute to the work of striving towards ground-truth in the era of interconnectedness.

The inspiration for SMAT originated from a series of open workshops to identify, monitor, and analyze misinformation and disinformation within social media related content. Over the course of these workshops, a common theme was the lack of easy to use, open-source tooling to perform exploratory analysis across huge datasets. None of the partic-

ipants were computer scientists, and they all noted a lack of end-user accessibility to large-scale analysis methods as a barrier to exploring some of their research questions. To address this we created SMAT.

In this paper, we present the design of SMAT, its operations and functionality, and its practicality in two tangible open-source intelligence research applications (Glassman and Kang 2012). The rest of this paper is organized as follows. In Section 2 we discuss related systems used for similar applications and examine ways in which SMAT compares to these. Then in Section 3 we highlight the large, live collections of social networking data feeding SMAT. Section 4 details the middleware component of the application stack to highlight its ease of use for facilitating the development of the UI. Section 5 examines the various operations and visualizations an end-user can utilize using SMAT for research. We show in section 6 how SMAT can be used for past and present open-source intelligence investigations. Finally, we discuss and conclude in Section 7.

2 Related Work

Work related to SMAT ranges from other open-source intelligence web applications to the various academic papers based on the same Pushshift datasets. In this section we explore other existing tools which compare to SMAT and various academic papers highlighting analyses performed across Pushshift datasets.

Open Intelligence Applications

SMAT falls within a wide category of applications used for intelligence (Glassman and Kang 2012). Some of these applications, like SMAT, can be considered open-source (in terms of public code), or in the broader popular category of open-source intelligence (OSINT) in that they use publicly accessible data.

Some other example related applications are Facebook’s Crowdtangle² which markets itself as allowing users to “stay on top of stories that matter”, “benchmark against competitors”, and “identify influencers”. Although related in the sense that it is based on social media data, CrowdTangle is

vastly different than SMAT for one because it is not open-source, but also because it does not support all the datasets that SMAT does.

A second example application is “OSOME”, a joint project by several groups at Indiana University. This tool combines several published works by researchers in those groups to detect automated bot activity on Twitter (Yang et al. 2020; Hui et al. 2019; Yang et al. 2019) and has proven their framework’s network visualization approach value by several in-depth published real-work applications (Pacheco, Flammini, and Menczer 2019; Shao et al. 2016). The main separation between SMAT and this application is the various datasets. Our implementation of SMAT relies on at least three data sets while theirs is only Twitter.

Lastly, there are other tools like SMAT which are open-source, mainly MediaCloud³. The significant difference again between SMAT and MediaCloud is that we propose an application which currently sources native content from three different social media datasets. This means that by using SMAT, users are able to analyze actual posted content across these social networks, where as with a tool like MediaCloud, users are limited to post-processed content and fewer social networks.

Pushshift

The development of SMAT relies on several collected Pushshift datasets. Pushshift is an Elasticsearch cluster that is indexing streaming data collected from a range of different platforms. The Pushshift Reddit dataset (Baumgartner et al. 2020) has been used in dozens of academic publications (Chandrasekharan et al. 2017; Chatzakou et al. 2019; Founta et al. 2018; Zampieri et al. 2019; Zannettou et al. 2018b; 2017; LaViolette and Hogan 2019; An et al. 2019; Datta and Adar 2019; Kumar et al. 2018; Thukral et al. 2018) and is a real-time source of live Reddit data.

In the future, we plan to incorporate other Pushshift datasets as well like Telegram (Baumgartner et al. 2020) and 4chan (Papasavva et al. 2020) which would bring the total social media data set count up to 6, a count that as we are aware of is the largest for any open-source social media analysis tool.

Methods for Critical Internet Studies

SMAT takes frameworks from prior studies on methods for analyzing social media data. For example, Acket et al. (2019) focused on how data should be collected, archived, and analyzed for disinformation studies. The authors strictly called out account names, followers, and content tags all as various metadata critical to study these types of events. We built SMAT so that these metadata attributes are accessible and in some operations analyzed already. Additionally, SMAT is fully supported by multiple datasets which are collected and archived regularly. Furthermore, more comprehensive data can be attained through interacting directly with our middleware API layer.

³<https://mediacloud.org/>

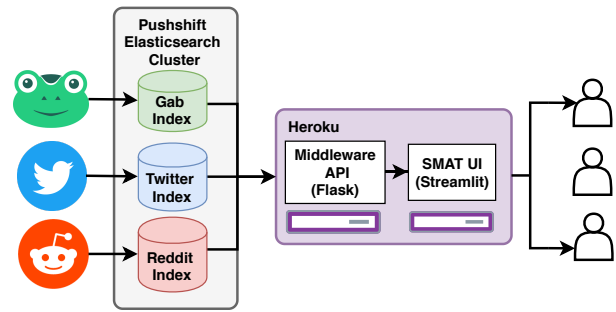


Figure 1: SMAT system architecture. First, data is collected from social media sites, and ingested into Pushshift data stores. We build a middleware API layer and SMAT UI which are deployed in Heroku.

3 Datasets

Currently SMAT supports three Pushshift collected data sets. These collections are ingested in a streaming fashion such that they are always up to date at the time a query is performed in SMAT. This section outlines the various descriptions of each dataset.

Twitter Pushshift’s Twitter dataset includes all tweets from verified accounts. At the time of writing this dataset had 1.7 billion unique tweets. The dataset spans from March 2006 and is continually updated.

Reddit Reddit, the so called “front page of the internet,” is a content aggregation and discussion platform with currently about 542 million users at the time of this writing. Reddit’s subreddit system allows for the creation of specialized communities focused around a particular topic, and the main page displays trending content across a variety of subreddits. The Pushshift Reddit dataset (Baumgartner et al. 2020) includes data since June 2005 and is continuously updated. It includes 7.5 billion comments at the time of writing.

Gab Gab is a social network which launched in August of 2016. According to the website the motive is that it “champions free speech, individual liberty, and the free flow of information online. All are welcome.” Gab is similar to Twitter in that there are individual users which can write messages, called “gabs”, to their followers. The Pushshift Gab dataset contains 40 million unique posts at the time of writing. The dataset spans from August 2016 and is continually updated. Gab has also been referred to by some as an “Alt-right Echo Chamber (Zannettou et al. 2018a).”

4 Middleware System Architecture

The basic architecture of the system consists of a Pushshift Elasticsearch cluster in the back-end where a range of datasets are indexed. From there we built an intermediary wrapper API that makes it easier to interact with the Pushshift Elasticsearch data store. We designed various simple endpoints for the intermediate API layer to allow other

⁴<https://gab.com/>

developers an easy way to make requests for data. The middleware stack is a lightweight python flask⁵ application running on a Heroku free tier node. We expect that free tier level resources would take our application stack far, and are not concerned about data or computation size with regard to the current tools and the query limits imposed. We are able to handle simultaneous requests by utilizing the gunicorn⁶ python package, which is “a python WSGI HTTP server for UNIX.” The main job of the middleware component is to request data from another service and pass it to the user interacting with the API or a web UI application. For end users of SMAT, this means that the complexity of writing custom Elasticsearch aggregation queries is hidden.

Middleware Endpoints

We currently deployed our middleware layer with three main endpoints. These endpoints support both the various front-end visualizations but also allow for open-source developers, researchers, and other users to easily interface with the native Pushshift data store. We utilize the Elasticsearch query power across all endpoints which facilitates low-latency exact match query string keyword searches. In other words, each endpoint supports quickly searching for a specific term. The required common parameters across endpoints are the keyword search term parameter, a date range in form of since to until, and the site to search against. There is a configurable back-end limit of 10,000 results for all endpoints that also collect the content of messages.

Timeseries The timeseries endpoint additionally requires a date-time interval to aggregate across. For example, if the user provided the search term “election”, the site “twitter” and the interval “week” then the middleware would return an aggregation where each bucket is a week in the time range and the bucket counts are the number of tweets in that bucket which contain the term “election”. This endpoint is particularly useful when measuring activity on a site related to a particular topic, event, person or term over time. Because this endpoint is not gathering the content of messages, it does not have the limits we impose on other search parameters.

Activity The activity endpoint returns an aggregation across a site specific attribute. Activity aggregates across user accounts on the various datasets and additionally across “subreddits” on Reddit. For example, if a user was interested in which accounts mention a term the most on Gab, they would aggregate on author and receive a response which is each author’s username and the number of times they mentioned that term.

Content Lastly, the content endpoint just returns a plain content response without any aggregation. This endpoint allows users to search for specific term on a site and get back a response which are the literal tweets, posts, or gabs which match. Currently only the link and hashtag detector tools utilize this endpoint, but there are various other investigative research operations for which it is a stepping stone. This

⁵<https://flask.palletsprojects.com/en/1.1.x/>

⁶<https://gunicorn.org/>

endpoint additionally supports the “limit” parameter which allows the user to specify the number of results they would like returned.

5 SMAT Streamlit UI

The current SMAT production version (SMAT) utilizes the Streamlit⁷ python package. The entire user-interface is also translated into Spanish and can take most scripts as input such as Arabic or Mandarin.

Operations

We split the UI for SMAT into four main operations. Each operation supports a different measurement across each site. These operations are powered by the middleware endpoints and support various research and investigate use-cases. In this section, we describe the operations and how they behave and are configured.

Timeline The timeline operation is a timeseries plot of activity on a platform over time. This operation utilizes the `timeseries` endpoint because the figure is powered by volume over time for the user’s search term. Figure 3 shows the daily timeline operation on all three sites for the term “covid-19”. This example graph shows how discussion of the topic across various platforms follows different patterns. For example, tweet volume follows a more cycling inter-day pattern while reddit posts follow a more consistent daily pattern and gab has several days where the term is not mentioned at all.

Changepoint Analysis (CPA). CPA provides a quantification of when significant (in the statistical sense) changes in a time series occur. In short, if you have a lot of spikes or change in volume, you want to know which moment indicates a significant difference from past activity. CPA comes in two flavors: in one, the goal is to detect a mean shift, while in the other the goal is to detect a variance shift. Currently, SMAT only implements the mean shift variant. The algorithm (Taylor 2000) segments a time series into two parts, one before and one after the changepoint, by taking a cumulative sum over differences and testing it over as many permutations as is computationally feasible. If the cumulative sum of differences changes past a critical value under the permutation, then we say that there has been a significant mean shift in the data. Users of SMAT are able to configure CPA to run on hourly, daily, or weekly intervals. Figure 4 shows an example CPA run against all sites for the term “impeachment.” From the figure we can see a significant change in activity occurred on Twitter several days before the other two sites we are comparing against.

Link counter The link counter operation compares link volume related to the input search term. This operation is fueled by the `content` endpoint because we need the raw text data from the various social networks in order to parse out the mentioned links. The counter displays a bar plot where each bar on the y-axis is a link that was mentioned on the platform. If the link is shortened, the tool attempts to find the expanded URL. This tool was inspired by the results

⁷<https://www.streamlit.io/>

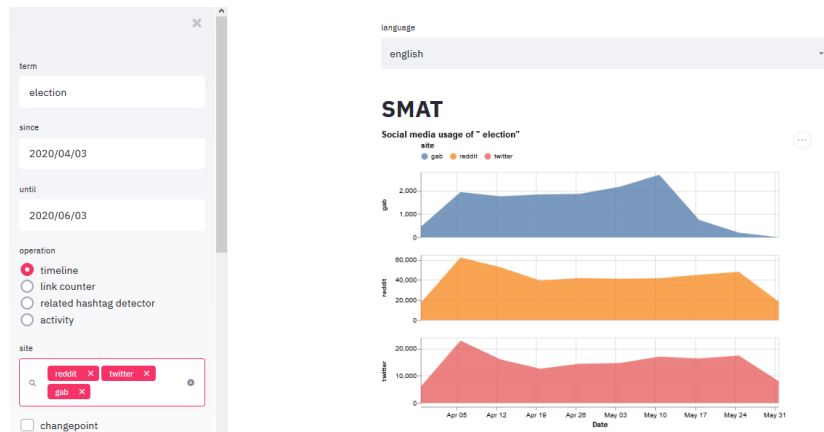


Figure 2: A screen-shot of the SMAT UI user view. The user interfaces on the left hand side with the various application variables like date, operation, site and search term. The main middle portion of the UI displays the operation visualization based on the configured application variables and search term.

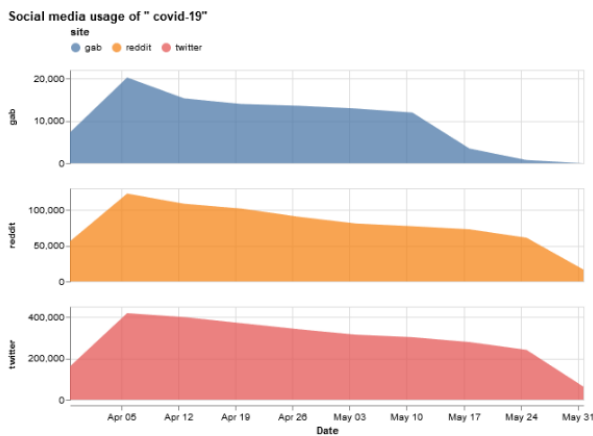


Figure 3: SMAT timeline displaying declining daily results for the search term “covid-19” between April 3, 2020 - May 31, 2020 on Twitter, Gab, and reddit.

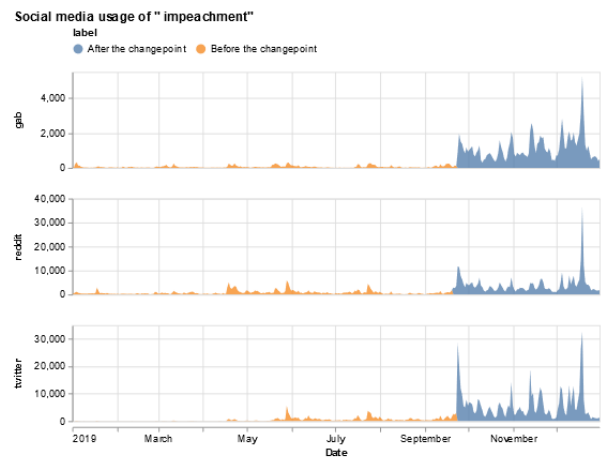


Figure 4: Changepoint Analysis run against all sites for all of 2019 with the term 'impeachment'. We see a significant changepoint and peak occur on Twitter before any other site.

of an exploratory study that looked at external links to analyze the ecosystems of the alt-right extremist forum 8chan (Bevenssee and Ross 2018).

Figure 5 displays the top links on Gab from January 2020 - April 2020 where the top links are sorted on the y-axis in descending order and the x-axis is log scale. The operation shows the top 15 links by default however SMAT displays a slider from 1-50.

Hashtags The hashtags operation pulls all hashtags from Twitter related to a search term. This operation utilizes the content middleware endpoint because it returns the raw data associated with a search, including the literal Tweets and their associated pre-calculated hashtags. The hashtags operation behaves similarly to the link counter in that the user is able to configure the number of hashtags to graph. Figure 6 displays top hashtags from 2019 which mention the

search term “trump”. The y-axis displays the top hashtags in descending order and the x-axis is their volume in log scale. This operation is particularly useful for a SMAT user attempting to discover what other hashtags users are utilizing in conjunction with a given one. Oftentimes, unpredictable links between communities and topics can be discovered this way.

Activity The last operation, activity, allows a SMAT user to aggregate across various site specific fields. On Reddit users can aggregate across author and subreddit whereas on Twitter and Gab, users can aggregate across user activity. The visualization for this operation is backed entirely by the activity endpoint itself with minimal post processing for display purposes. We supply to the middleware activity endpoint; the site, the search term, and the field to aggregate by. Figure 7 depicts the top subreddits from January 2020 -

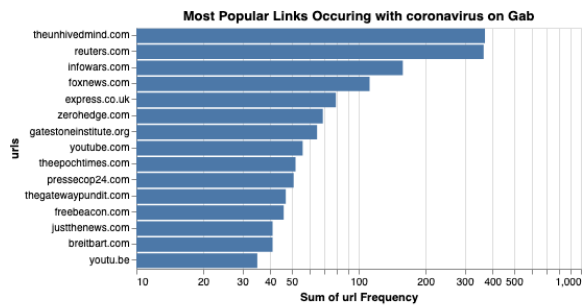


Figure 5: Sample link counter operation where the search term was “coronavirus” and the site is “Gab” from January 2020 - April 2020. This operation displays the various domains referenced on Gab when that search term is mentioned.

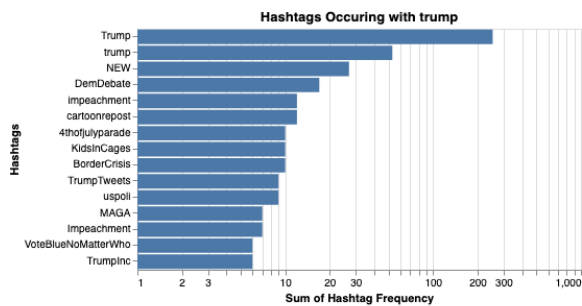


Figure 6: Figure displaying the top hashtags on Twitter in 2019 where the tweet also mentioned the search term “trump”.

April 2020 with some mention of the term “covid”. Unsurprisingly these are almost entirely subreddits about the topic or word news and politics.

Deployment

We are able to run both the middleware and front-end components for SMAT in Heroku’s free tier. We implemented default query limit sizes for both components, and max out the total results size at 10,000 for searches that utilize the content endpoint. This allows the applications to avoid any computational resource limits due to sizable data being held in memory. The most computationally expensive operation with the highest latency is the changepoint analysis in the UI component. The changepoint function could be multi-processed in the future to improve speed and performance. Overall both applications run well within the resource limits of the Heroku free tier and so could chew up a lot more resources before a deployment needs an updated tier.

6 Case Studies

Having provided an overview of SMAT’s design and features, we now show how SMAT can be used to quickly find evidence related to emerging research questions via two case studies. First, we use SMAT to explore shifts in so called

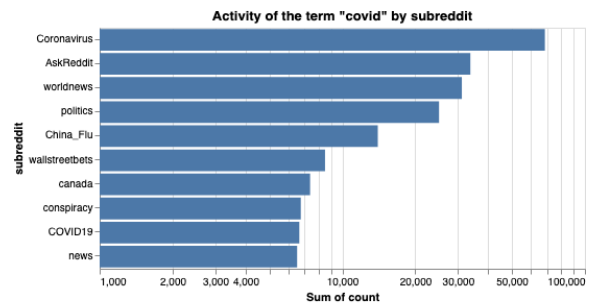


Figure 7: This figure depicts the activity operation aggregating by top subreddits which mention “covid” from January 2020 - April 2020.

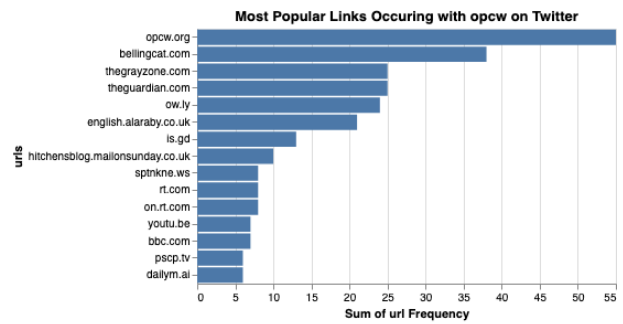


Figure 8: Links extracted from verified tweets containing the term OPCW between January 24 and February 24th of 2020.

“echo-systems” of disinformation related to Syria. Next, we explore how a conspiracy theory related to the UN has recently become associated with the COVID-19 pandemic.

Disinformation Analysis Pivoting

Dangerous cross-contamination of both academic and alternative media landscapes with disinformation can cause great harm to a knowledge ecosystem. Politically motivated, weaponized conspiracy networks are one example of a specific genre of misinformation that SMAT can measure. Starbird et al. (2018) previously conducted research into an “echo-system” of dis- and misinformation around the White Helmets in Syria. Their research demonstrated how different categories of conspiracy theories can overlap, draw from related or disparate communities, and spread to a wider audience. SMAT can augment this previously conducted research into an “echo-system” of dis- and misinformation by examining the discourse of other related conspiracy networks.

We thus use SMAT to examine discussion around the Organisation for the Prohibition of Chemical Weapons (OPCW) and chemical weapons usage in Syria because the same conspirators as those surrounding the White Helmets, are known to share false information about both of these related topics (21stCenturyWire). We used SMAT to investigate the links in tweets mentioning “OPCW.” Figure 8 shows that among verified Twitter users alone, we see many links to

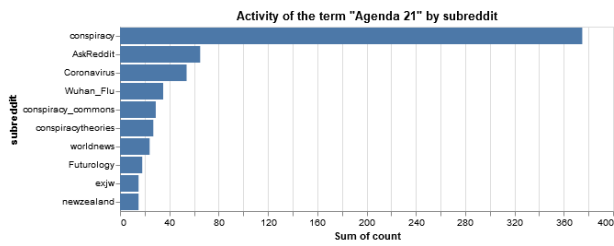


Figure 9: References to the Agenda 21 conspiracy theory aggregated by subreddit.

new sources spreading the counter-narrative that the Assad regime did not use chemical weapons in Syria. Sites such as “Russia Today (RT),” “Sputnik News,” and “21st Century Wire” were all mentioned in the Starbird et al. (2018) study. These findings are reinforced by another study by Reid Ross, which used earlier versions of SMAT to look at Russian disinformation (2019).

Additionally, “The Grayzone” appeared in our SMAT search results, which was *not* accounted for in (Starbird et al. 2018). We pivoted to investigate this additional source and found references (Mate 2020) in its OPCW investigation to studies conducted in conjunction with a weaponized science organization called the Organisation for Propaganda Studies. This organisation was founded by a 9/11 (York 2018) and Corona virus (Kennedy 2020) conspiracy theorist who is also trying to shift public perceptions around Syria and other geopolitical issues.

Agenda 21 Conspiracy

Agenda 21 is a relatively well established conspiracy theory related to sustainability. In 1992 the UN produced a document called Agenda 21 which contained guidelines to reach environmental sustainability (UN 1992). Conspiracy theorists believe that this (non-binding) resolution is actually a plot to put humanity under the control of a cabal of eco-obsessed tyrants (Dickson 2017). As well, this conspiracy theory features prominently on 21st Century Wire (Malić 2016) and versions of it were spread by the founder of the Organisation for Propaganda Studies (Kennedy 2020), both of which were found spreading Syria conspiracies using SMAT in the previous section.

While a deeper exploration of the Agenda 21 conspiracy is out of scope for this paper, it has recently seen a resurgence along with the rise of COVID-19 (Beck 2020), and thus serves as a relevant case study to demonstrate the type of exploratory analysis of emerging phenomena SMAT enables. To that end, we set out to get a first pass understanding of *where*, *when*, and *how* the Agenda 21 conspiracy theory has been linked to COVID-19.

We first make use of SMAT’s activity tool to find the subreddits discussing Agenda 21 the most. This can give us an idea of whether the re-emergence is isolated to the “typical” conspiracy theorist community or if is making its way to more main stream communities. Figure 9 shows the subreddits with the most mentions of “Agenda 21” from Jan-

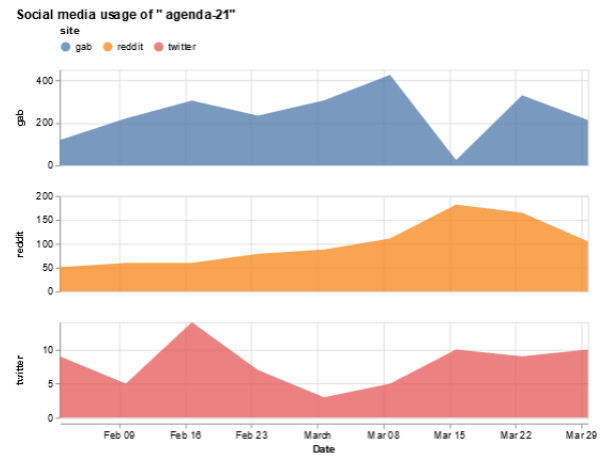


Figure 10: Timeline of comments containing the term “agenda-21” compared across multiple forums from February 4, 2020 to April 4, 2020.

uary 1st, 2020 to April 26th, 2020. From the figure, we see that the subreddit where Agenda 21 is “most popular” is /r/conspiracy, the home to Reddit’s top minds in terms of conspiracy theory discussion. Rounding out the top three, we see /r/AskReddit and /r/Coronavirus. Both are much more mainstream than /r/conspiracy, and /r/Coronavirus (Reddit’s admin endorsed COVID-19 subreddit) in particular is indicative of the resurgence of the Agenda 21 in relation to COVID-19. This also implies that the conspiracies are beginning to muddle time-sensitive discourse in mainstream reddit channels related to Covid-19 safety protocols.

While Reddit’s struggles with dangerous content are well known, its moderation system and admins’ actions towards worrying subcommunities does tend to have at least some effect on what content appears there. In fact, platforms like Gab exist to essentially work outside the moderation policies of more mainstream platforms. This indicates that some degree of multi-platform analysis is necessary to get a more full picture of the Agenda 21 conspiracy theory with respect to COVID-19.

Thus, in Figure 10 we use SMAT’s timeline tool to show how Agenda 21 related activity from January 1, 2019 to April 26, 2020 on Gab, Reddit, and Twitter. We can see that Gab, arguably the largest alt-right oriented social media platform (Zannettou et al. 2018a), is discussing Agenda 21 the most. This is interesting because Gab has substantially fewer users than Reddit (Baumgartner et al. 2020; Zannettou et al. 2018a) and thus this conspiracy is being spread among a higher overall percentage of its user-base. Although Gab had the latest peak of usage around April 19th, even its lower usage periods were almost always higher than the other platforms. This peak appears within days after the release by Daily Beast of a popular debunking of the conspiracy (Dickson 2017). Though the numbers overall may seem small, the spread of this kind of misinformation in conjunction with weaponized science organisations and conspiracy prone “alternative” media networks can lead to

dangerous real world results. One such example related to Agenda 21 is neo-nazis spreading the passwords and emails of World Health Organization and Gates Foundation Employees (Makuch 2020). SMAT can help elucidate directions for further exploration and expose these dangerous trends.

7 Discussion & Conclusion

Social media has rapidly accelerated the dissemination of information, enabled social movements, and also been used for exploiting weaknesses in society. Unfortunately, the scale and speed at which social media moves poses challenges for many researchers from non-computer science backgrounds, and even those with computer science backgrounds still find value in easy to perform exploratory analysis.

SMAT is not without its limitations. For example, there are some limitations with respect to the communication between our middleware and Pushshift's ElasticSearch backend. This is addressable by implementing a client that supports the ElasticSearch scroll framework, which would as an added benefit allow us to provide real-time results in a streaming fashion. Additionally, we would like to include un-verified Twitter accounts to better address hate and disinformation on the platform but this is currently complicated by Terms of Service questions. However with verified accounts it is more possible to control against bot activity. Ideally we will implement the choice to include all of Twitter or just verified accounts.

We are currently working towards incorporating additional data from Telegram, MeetUp, and 4chan into SMAT. We additionally have plans to make changes to the middleware components to allow for additional analysis endpoints (e.g. network analysis and unsupervised machine learning) and provide options to aggregate around augmented fields in Pushshift's dataset (e.g., named entities). SMAT is currently open-source and we are operating a deployment.

In this paper, we presented SMAT, a user friendly application that provides a suite of tools for analyzing social media. SMAT is accessed via a Web browser, and allows researchers to get actionable, real-time analyses across a variety of axes and social media platforms. For example, SMAT allows a user to compare *when* significant changes in discourse happened across Reddit, Twitter, and Gab or to find other leads to pursue, such as related links, hashtags, or subreddits in the course of an open-source investigation. We thus SMAT as a meaningful contribution to not just academic research, but journalism, and activism as well.

References

21stCenturyWire. OPCW Tag. <https://web.archive.org/web/20200426234824/https://21stcenturywire.com/tag/opcw/>.

Acker, A., and Donovan, J. 2019. Data craft: a theory/methods package for critical internet studies. *Information, Communication & Society* 22(11):1590–1609.

An, J.; Kwak, H.; Posegga, O.; and Jungherr, A. 2019. Political discussions in homogeneous and cross-cutting communication spaces. *Proceedings of the International AAAI Conference on Web and Social Media* 13(01):68–79.

Baumgartner, J.; Zannettou, S.; Keegan, B.; Squire, M.; and Blackburn, J. 2020. The Pushshift Reddit Dataset. In *Proceedings of the 14th International AAAI Conference on Web and Social Media*, ICWSM '20.

Beck, G. 2020. EXPOSED: Governments using the coronavirus pandemic to finalize 'Agenda 21' social planning revolution. <https://www.glennbeck.com/theblaze-tv/exposed-governments-using-the-coronavirus-pandemic-to-finalize-agenda-21-social-planning-revolution>.

Bevensee, E., and Ross, A. R. 2018. The alt-right and global information warfare. In *2018 IEEE International Conference on Big Data (Big Data)*, 4393–4402. IEEE.

Chandrasekharan, E.; Pavalanathan, U.; Srinivasan, A.; Glynn, A.; Eisenstein, J.; and Gilbert, E. 2017. You can't stay here: The efficacy of reddit's 2015 ban examined through hate speech. *Proc. ACM Hum.-Comput. Interact.* 1(CSCW):31:1–31:22.

Chatzakou, D.; Leontiadis, I.; Blackburn, J.; Cristofaro, E. D.; Stringhini, G.; Vakali, A.; and Kourtellis, N. 2019. Detecting cyberbullying and cyberaggression in social media.

Datta, S., and Adar, E. 2019. Extracting inter-community conflicts in reddit. *Proceedings of the International AAAI Conference on Web and Social Media* 13(01):146–157.

Dickson, C. 2017. Agenda 21: The UN Conspiracy That Just Won't Die. <https://www.thedailybeast.com/agenda-21-the-un-conspiracy-that-just-wont-die>.

Founta, A.-M.; Chatzakou, D.; Kourtellis, N.; Blackburn, J.; Vakali, A.; and Leontiadis, I. 2018. A unified deep learning architecture for abuse detection.

Glassman, M., and Kang, M. J. 2012. Intelligence in the internet age: The emergence and evolution of open source intelligence (osint). *Computers in Human Behavior* 28(2).

Hui, P.-M.; Yang, K.-C.; Torres-Lugo, C.; Monroe, Z.; McCarty, M.; Serrette, B.; Pentchev, V.; and Menczer, F. 2019. BotSlayer: Real-time detection of bot amplification on Twitter. *Journal of Open Source Software* 4(42):1706.

Kennedy, D. 2020. This Professor Teaches Journalism At A Top UK University. He's Also A 9/11 Truther. <https://www.thetimes.co.uk/article/british-academics-sharing-coronavirus-conspiracy-theories-online-v8nn99zmv>.

Kumar, S.; Hamilton, W. L.; Leskovec, J.; and Jurafsky, D. 2018. Community interaction and conflict on the web. In *Proceedings of the 2018 World Wide Web Conference, WWW '18*, 933–943. Republic and Canton of Geneva, Switzerland: International World Wide Web Conferences Steering Committee.

LaViolette, J., and Hogan, B. 2019. Using platform signals for distinguishing discourses: The case of men's rights and men's liberation on reddit. *Proceedings of the International AAAI Conference on Web and Social Media* 13(01):323–334.

Makuch, B. 2020. Neo-Nazis Are Spreading a List of Emails and Passwords for Gates Foundation and WHO Employees. https://www.vice.com/en_us/article/akwxzp/neo

nazis-are-spreading-a-list-of-emails-and-passwords-for-gates-foundation-and-who-employees.

Malić, B. 2016. Agenda 21: An Introduction. <https://web.archive.org/web/20200504174353/https://21stcenturywire.com/2016/05/08/agenda-21-an-introduction/>.

Mate, A. 2020. Exclusive: New OPCW whistleblower slams 'abhorrent mistreatment' of Douma investigators. <https://web.archive.org/web/20200424023610/https://thegrayzone.com/2020/03/12/opcw-whistleblower-mistreatment-douma-investigators/>.

Pacheco, D.; Flammini, A.; and Menczer, F. 2019. What is going on Brazil? A Political Tale from Tweets. Presented at 8th Intl. Conference on Complex Networks and their Applications.

Papasavva, A.; Zannettou, S.; Cristofaro, E. D.; Stringhini, G.; and Blackburn, J. 2020. Raiders of the lost kek: 3.5 years of augmented 4chan posts from the politically incorrect board.

Ross, A. R. 2019. Fooling the nation: Extremism and the pro-russia disinformation ecosystem. <http://www.boundary2.org/2019/11/alexander-reid-ross-fooling-the-nation-extremism-and-the-pro-russia-disinformation-ecosystem/>.

Shao, C.; Ciampaglia, G. L.; Flammini, A.; and Menczer, F. 2016. Hoaxy: A platform for tracking online misinformation. In *Proc. 25th International Conference Companion on World Wide Web*. Preprint arXiv:1603.01511.

SMAT. Smat. <https://smat-streamlit.herokuapp.com/>.

Starbird, K.; Arif, A.; Wilson, T.; Koevering, K. V.; Yefimova, K.; and Scarnecchia, D. 2018. Ecosystem or echo-system? exploring content sharing across alternative media domains. In *Twealth International AAAI Conference on Web and Social Media*.

Taylor, W. A. 2000. Change-point analysis: a powerful new tool for detecting changes.

Thukral, S.; Meisheri, H.; Kataria, T.; Agarwal, A.; Verma, I.; Chatterjee, A.; and Dey, L. 2018. Analyzing behavioral trends in community driven discussion platforms like reddit. *CoRR* abs/1809.07087.

UN. 1992. United Nations Conference on Environment & Development. <https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf>.

Yang, K.-C.; Varol, O.; Davis, C. A.; Ferrara, E.; Flammini, A.; and Menczer, F. 2019. Arming the public with artificial intelligence to counter social bots. *Human Behavior and Emerging Technologies* 1(1):48–61.

Yang, K.-C.; Varol, O.; Hui, P.-M.; and Menczer, F. 2020. Scalable and generalizable social bot detection through data selection. In *Proc. 34th AAAI Conf. on Artificial Intelligence (AAAI)*. arXiv preprint <https://arxiv.org/abs/1911.09179>.

York, C. 2018. This Professor Teaches Journalism At A Top UK University. He's Also A 9/11 Truther. https://www.huffpost.com/entry/professor-piers-robinson-sheffield-university_n_5c0666a3e4b07aec5752630a.

Zampieri, M.; Malmasi, S.; Nakov, P.; Rosenthal, S.; Farra, N.; and Kumar, R. 2019. Predicting the type and target of offensive posts in social media. In *Proceedings of the 2019 Conference of the North American Chapter of the Association for Computational Linguistics: Human Language Technologies, Volume 1 (Long and Short Papers)*, 1415–1420. Minneapolis, Minnesota: Association for Computational Linguistics.

Zannettou, S.; Caulfield, T.; Cristofaro, E. D.; Kourtellis, N.; Leontiadis, I.; Sirivianos, M.; Stringhini, G.; and Blackburn, J. 2017. The web centipede: Understanding how web communities influence each other through the lens of mainstream and alternative news sources. *CoRR* abs/1705.06947.

Zannettou, S.; Bradlyn, B.; De Cristofaro, E.; Sirivianos, M.; Stringhini, G.; Kwak, H.; and Blackburn, J. 2018a. What is Gab? A Bastion of Free Speech or an Alt-Right Echo Chamber? In *WWW Companion*.

Zannettou, S.; Caulfield, T.; Blackburn, J.; Cristofaro, E. D.; Sirivianos, M.; Stringhini, G.; and Suarez-Tangil, G. 2018b. On the origins of memes by means of fringe web communities. *CoRR* abs/1805.12512.