An Exploration of Decentralized Moderation on Mastodon

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ABSTRACT

Decentralized Online Social Networks (DOSNs) are rising as a valid alternative to traditional centralized platforms like X (Twitter) and Facebook. Mastodon is to date the most widely recognized decentralized social media service. Thousands of servers have been deployed in the last few years due to the availability of open-source software which allows anyone to easily join the network of interconnected servers. Nonetheless, akin to other social media, Mastodon encompasses instances that host harmful or inappropriate content, which demands moderation. However, the *decentralized* nature of Mastodon servers poses novel challenges for content moderation. In this work, we explore the dynamics of decentralized moderation on Mastodon through the main tool offered to servers' administrators, namely *blocklisting* servers to prevent users of an instance from interacting with the content of these servers. Our goal is to shed light on the main traits that characterize blocklisted instances on Mastodon and investigate the emergence of common blocklisting patterns toward specific groups of instances.

CCS CONCEPTS

• **Information systems** → **Data mining**.

KEYWORDS

Mastodon, Social, Network, Content, Moderation

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1 INTRODUCTION

The social media landscape has changed dramatically in recent years, driven by a growing dissatisfaction with the centralized paradigm and the increasing enforcement of policies that have to be passively accepted, as in the case of Twitter (now *X*). In response, a dedicated shift toward decentralization has emerged in the realm of social networking, resulting in the establishment of the decentralized paradigm and the rise of Decentralized Online Social Networks (DOSNs).

DOSNs, akin to email services, allow anyone to create a new server (dubbed *instance*) and seamlessly join the network. The main mission of such platforms is, hence, to restore the pivotal role of users in social interactions, by getting rid of artificial boosting mechanisms of interactions and content (e.g., recommending whom to follow, or pushing non-chronological timelines). This mission witnessed a rapid proliferation of decentralized services, as in the case of *Mastodon* and *Pleroma* for microblogging. *Mastodon*, currently the most prominent DOSN, hosts around 16K instances forming the Fediverse, i.e., the federated universe of decentralized instances, encompassing more than 10M users to date.

The horizontal growth determined by the possibility of setting up own servers fosters the proliferation of independent yet cooperating instances focused on specific topics (analogously to sub-Reddits), thus requiring particular effort in content moderation.

Nonetheless, differently from centralized platforms where moderation capabilities are centered around a single touchpoint (e.g., a single platform) and managed by a "cohesive" or coordinated board of moderators, decentralization scatters such capabilities and efforts, thus adding a layer of complexity. Indeed, each Mastodon instance encompasses a set of administrators and moderators who are in charge of handling and filtering the content that flows across their instance.

However, instances are all but isolated, and content produced in an instance easily traverses multiple instances; for example, fake news generated on an instance can immediately traverse the Fediverse, thus affecting other instances. As a result, content moderation is a remarkable challenge in DOSNs, as it not only requires handling internally produced content, yet filtering and managing relationships with other instances.

Notably, to face such challenges, Mastodon open-source software provides instance administrators with a wide set of features, including those allowing for the enforcement of decentralized moderation policies toward other instances. Among these, particular attention is to be paid to the so-called *blocklisting* mechanisms, allowing the definition of rules aimed at preventing relationships with specific instances, thus avoiding the spreading of unwanted content (e.g., hateful, harmful, NSFW, etc).

In this work, we aim to fill a gap in understanding the dynamics behind the crucial moderation functionalities in Mastodon to frame the benefits and potential misuses of the latter, hence quantifying their impact in the Fediverse.

Related work. Although the concept of decentralization in the social landscape has recently become mainstream, this paradigm has been studied by scholars from different disciplines for several years [5, 6]. Mastodon rises as the platform that has attracted the most attention from the research community [4, 14, 18, 19, 22–24].

Zulli et al. [24] leveraged qualitative interviews to investigate how Mastodon fosters content diversification and community autonomy. Zignani et al. [22, 23] provided a network-based analysis of the Mastodon user interactions, comparing it with Twitter [22], discovering a more balanced followers-followee distribution and a limited presence of social bots on Mastodon (around 5%) compared to Twitter (around 15% [15, 20]), as well as distinctive assortativity traits. Zignani et al. also investigated how decentralization affects user relationships [23], unveiling that each instance possesses a distinct footprint that affects how users establish connections with each other. La Cava et al. [11] analyzed the network of Mastodon instances deriving from the cross-instance interactions of Mastodon users, exploring different perspectives (i.e., macroscopic, mesoscopic, and backbone) to shed light on the main traits that define Mastodon, also unveiling those that lead to the identification of a footprint compared to centralized platforms. Besides, they also investigated the impact of decentralization on user relationships [12], the main user roles related to information consumption and boundary-spanning phenomena in Mastodon, and shaped information consumption and production within DOSNs [13].

Content moderation in DOSNs has recently gained attention, as decentralization increases the complexity behind such a key task. Hassan et al. [7] evaluated the impact of decentralized content moderation on users in Pleroma, another emerging decentralized social platform. Zia et al. [2] investigated whether and to what extent toxic content spreads in Pleroma, also proposing a novel detection model. The Pleroma platform was also studied by Hassan et al. [1], who explored the issue of decentralized moderation. On Mastodon, Nicholson et al. [17] characterized the rules enforced by the most relevant instances, also comparing the resulting scenario with Reddit's content moderation.

Contributions. The emergence of new or aspirant decentralized platforms (e.g., *BlueSky* and *Threads*) and the large influx of new users towards them [8–10] demands particular attention to aspects of content moderation and governance [3] in DOSNs. Nonetheless, to the best of our knowledge, no works to date have explored the dynamics of moderation (e.g., through blocklisting) in Mastodon instances. To address this gap, our goal is to provide a first exploration and characterization of the dynamics behind instance moderation, a peculiar functionality in the Mastodon ecosystem. We formulate the following research questions:

- **(Q1)** What characterizes blocklisted instances on Mastodon?
- **(Q2)** How similar is blocklisting across different instances?

To answer our research questions, we collect blocklisting information for most active Mastodon instances and provide a first characterization of the most banned instances, including those responsible for spamming campaigns, as well as the motivations behind such bans.

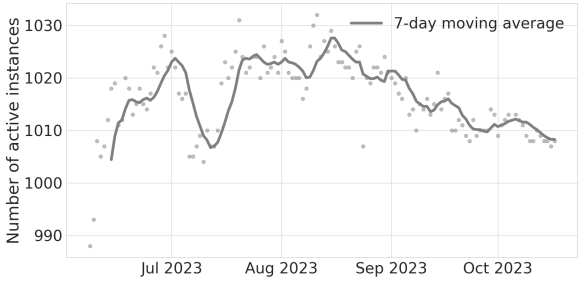

Figure 1: Daily number of Mastodon instances in our sample that are active between July and November 2023.

2 DATA COLLECTION

Mastodon provides public APIs that allow the collection of information about moderation strategies at the instance level.[1] Since enumerating existing instances is particularly challenging due to the scattering effect of decentralization and the continuous emergence of new instances, we rely on *instances.social*[2], a widely recognized aggregator of Mastodon instances that continuously traverses the Fediverse to discover and index new servers, currently covering about 16K instances.

We run the following procedure on a daily basis, between July 6th and November 15th, 2023. First, for each instance, we query the `GET /api/v2/instance` endpoint, which returns general information about the server; insofar, we only retrieve data related to instances that are online at the time of the collections, and that support Mastodon's API v2. Figure 1 reports the daily number of Mastodon instances active during the crawling period (approx. 1K on each day).

Next, we query each instance via the `GET /api/v1/instance/domain_blocks` endpoint: when available[3], this endpoint returns a list of *DomainBlocks* containing target instances that have been moderated – either *silenced* or *banned* – by the source instance, with the associated motivation. We also query the `GET /api/v1/instance/rules` endpoint to gather moderation rules for a given instance, and the `GET /api/v1/instance/activity` endpoint for the number of monthly active users.

Notice that instances may explicitly obfuscate a moderated instance, so as not to indirectly advertise them. We mitigate this incompleteness by matching obfuscated instances with known domains from our data when there is a unique match, e.g., we convert *m**todon.example* to *mastodon.example*.

[1] https://docs.joinmastodon.org/
[2] https://instances.social/
[3] Introduced with Mastodon v4.0.0 in November 2022.

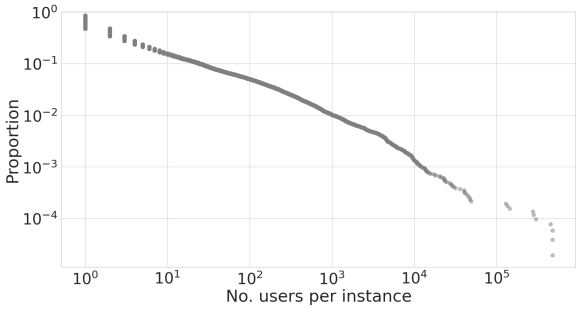

Figure 2: Distribution of the number of monthly active users for Mastodon instances.

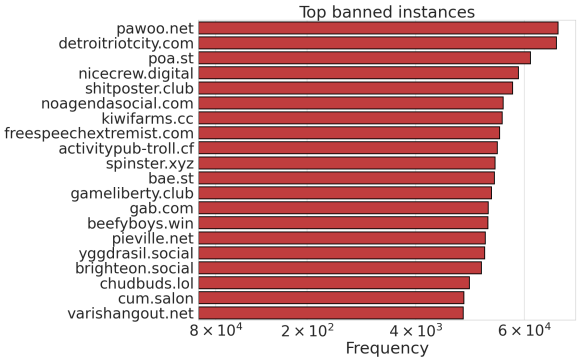

Figure 3: Most banned instances over time. Numbers report the cumulative number of observed bans.

3 RESULTS

Before delving into our research questions, we investigated the number of users potentially affected by blocklists adopted by active instances. Figure 2 illustrates how the number of users in active instances follows a power-law like distribution. This observation is particularly important for the largest instances; indeed, even if they represent only a small fraction of all active instances, their blocklists could prevent a large proportion of users from interacting with banned instances.

To answer **(Q1)**, we first analyzed the most frequently banned instances between July and November 2023, as reported in Figure 3. The most banned instance in our observation period is pawoo.net, the main Japanese instance. It is the second-largest Mastodon instance and has been part of the ecosystem for numerous years, being among the main contributors to the growth of the Fediverse during its early days. However, this instance has recently come under a magnifying glass due to a sudden and uncontrolled increase in sensitive content[4], which led to the enforcement of a ban against it by most Mastodon instances. Most of the top banned instances turn out to be characterized by the propensity for free speech, or alt-right political positions, as in the case of Gab (gab.com), an unofficial fork of Mastodon widely analyzed by scholars [16, 21] as a case study for hateful content spreading. Another interesting case

[4]https://en.wikipedia.org/wiki/Mastodon_(social_network)#Large_and_corporate_instances

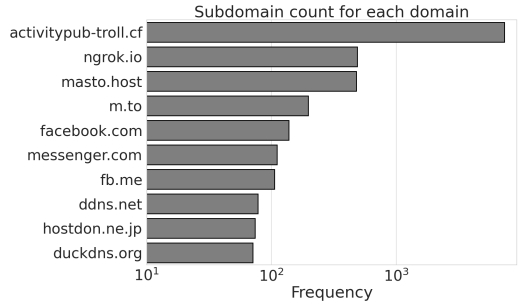

Figure 4: Number of banned subdomains per each domain.

in point is activitypub-troll.cf, which has been banned from many instances as responsible for spam attacks to timelines [5], resulting in overloaded instances and moderation overhead due to post management. The remainder contains instances mainly banned due to the hosting of NSFW or potentially harmful content.

We further investigate the prevalence of potential spam attacks by enumerating subdomains present in blacklists which refer to the same domain, i.e., we collapse *XYZ.activitypub-troll.cf* and *XZY.activitypub-troll.cf* to *activitypub-troll.cf*. As reported in Figure 4, the most numerous domain turns out to be activitypub-troll.cf, which was reportedly originating several spam campaigns against Mastodon instances. We also notice ngrok.io[6], which is a tool that allows a service hosted in localhost to be made "public," and it is probably banned because of the proliferation of test instances that could bring noise into the ecosystem. The third most-banned domain is masto.host a well-known Mastodon hosting service (as hostdon.ne.jp, also among the most banned); this service allows anyone to set up an instance for a very small fee, and its ban could indicate an attempt at moderation toward the proliferation of test instances or harmful instances hosted there. Finally, we spotted domains pertaining to the broad umbrella of *Meta*, which may have been banned by many instances committed to avoiding interacting with and sharing content from its platforms.

To shed light on the rationale of moderation activity, we examine the most frequent keywords in the ban motivations in our data. As reported in Figure 5, we notice the presence of NSFW and other harmful terms, with a striking amount of bans motivated by the word "pen*s". The second most-used keyword refers to a platform that is explicitly declared censorship-free, from which many Mastodon instances have distanced themselves as a form of prevention from harmful and/or inappropriate content. Other moderation strategies refer to the presence of hateful content (e.g., "*speech*", "*hate*"), as well as prevention from potentially harmful (e.g., "*harassment*", "*transphobia*") content from free-speech instances. An interesting case in point is represented by the keywords "*federate*" and "*fedi*", suggesting the enforcing of moderation policies toward certain instances, in case they federate with others (e.g., spreading harmful content).

As previously hinted, the presence of "*facebook*" and "*meta*" among the most recurrent ban motivations is not random, as during our data collection period *Meta* launched its micro-blogging app

[5]https://github.com/mastodon/mastodon/issues/21977
[6]https://ngrok.com/

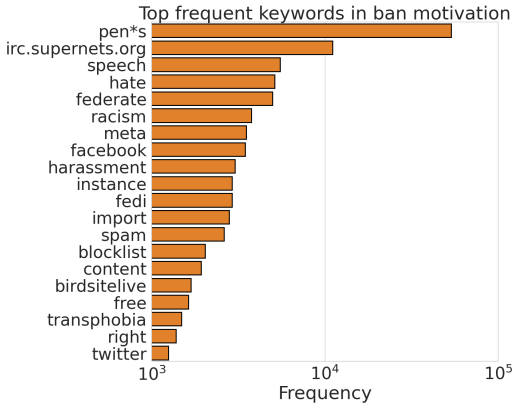

Figure 5: Most frequent lemmas in ban motivations.

Threads[7], which is intended to adopt shortly a decentralized protocol that would allow its users to interact seamlessly with Mastodon users.[8] This news has been received with particular attention by Mastodon users, leading to a preemptive ban of the threads.net domain to avoid "contamination" from Meta that might result in a domination of the Fediverse once they land, given their extensive user base. Further confirmation of the willingness to detach from centralized socials emerges from the presence of "*twitter*" and "*birdsitelive*", i.e., an *ActivityPub* (the protocol behind Mastodon) bridge from Twitter.

Finally, another interesting keyword is "*blocklist*", which refers to the existence of blocklists shared among admins of the various instances and publicly available online,[9] created to share moderation experiences and regulate the management of interactions with other instances, so as to limit dangers.

Mastodon instances typically declare a set of rules to be respected by their users in order to keep instances safe and healthy. We explored them to gain further insights into the moderation system behind the Fediverse. The most used keyword in Mastodon rules concerns "*content*", indicating particular attention from admins to regulate the type of information shared within and among instances. The remaining set of keywords indicates the kind of content they tend to keep away, i.e., illegal, harmful, racist, and violent content. Some keywords explicitly refer to avoiding spam and doxxing activities. We omit the figure for the sake of brevity.

For what concerns the geographical distribution of Mastodon instances, Figure 6 (left) shows the number of banned instances across countries, with the highest numbers in the United States, followed by France and Germany. However, such insight can provide only rough indications given the large proliferation of instances. Therefore, we normalized such scores by the total number of instances in each nation. As shown in Figure 6, the normalized scores are very different, indicating Europe (particularly in the north) and Russia as the countries that host the highest fraction of banned instances.

[7]https://www.threads.net/
[8]https://about.fb.com/news/2023/07/introducing-threads-new-app-text-sharing/
[9]https://github.com/gardenfence/blocklist

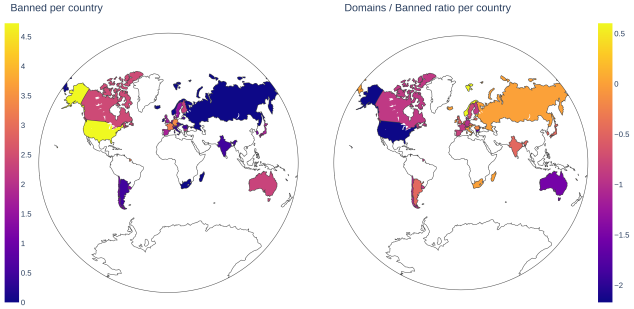

Figure 6: Number of banned instances per country (left) and ratio between known instances and banned instances per country (right), values in log_{10} scale.

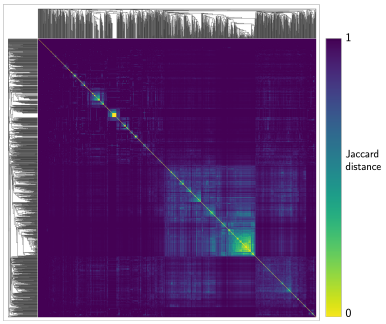

Figure 7: Pairwise Jaccard-based distance matrix of Mastodon instances computed on blacklists. Brighter colors correspond to smaller distances (and more similar blocklists).

To answer **(Q2)**, we focused on the importance of keeping the decentralized moderation mechanism as efficient and fair as possible. Indeed, it offers the side to two possible issues, namely (i) lack of distribution and control of ban lists, and (ii) abuse of ban lists to harm or destabilize the Fediverse.

While the latter is left to the common sense of the many admins and volunteers who contribute to the growth of the Fediverse, and regulate its dynamics so that it remains a healthy ecosystem, the former represents a concrete issue to date. We investigate to which extent admins automatically import publicly available blocklists curated by other people, possibly unaware of what they contain because of the sheer number of banned instances. The negative impact of such a choice lies in the risk that blocklists will be (voluntarily or involuntarily) contaminated. Therefore, instances adopting such lists — without scrutinizing them — will unwittingly enforce moderation against instances that might not deserve moderation.

We investigate similarity patterns in moderation activity among instances by computing pairwise Jaccard distances over the sets of banned domains for each instance, and extracting groups of similar instances by means of agglomerative clustering. Figure 7 shows the results of such clustering analysis, with most instances yielding pairwise distances close to one (darker color), thus signaling very diverse blocklists. However, a few clusters emerge (brighter colors),

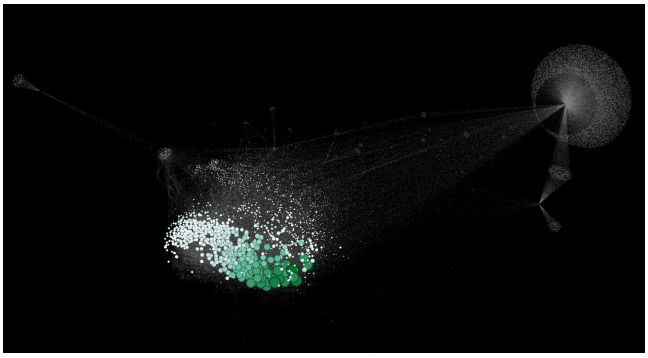

Figure 8: Network of Mastodon instances involved in moderation. Nodes represent instances, node size and color are proportional to the in-degree (i.e., number of received bans). The network is visualized with a force-directed layout.

hinting to shared concerns for groups of instances' admins toward specific harmful instances that require moderation.

To further delve into our **(Q2)**, we built a network of Mastodon instances involved in moderation dynamics. The network is built as a directed graph $G = \langle V, E \rangle$ such that the set V contains all Mastodon instances exercising or receiving moderation, and there exists an edge $(i, j) \in E$, if instance i includes instance j in its blocklist.

We first observe that the average in-degree of Mastodon instances, i.e., the number of received bans, ranges between 3 and 4. Besides, while the network exhibited a unique connected component in July 2023, starting from August we spotted the division of the network in at least two connected components, marking a shift in moderation dynamics.

Finally, as shown in Figure 8, the most banned instances tend to cluster together, denoting common patterns in moderation. Interestingly, the upper-right conglomerate is determined by an instance whose admin bans almost all the other instances.

4 CONCLUSIONS

Decentralized Online Social Networks (DOSNs) are witnessing a large influx of users and newly created instances, which necessitate increasing moderation efforts. However, despite the challenges posed by decentralization to content moderation, DOSNs equip server administrators with new tools designed to moderate relationships between servers. In this work, we focused on Mastodon, the most representative DOSN, and explored the dynamics of its blocklisting functionality. Our study explored the tool's effective use in maintaining the robustness of the DOSN ecosystem against potential threats or harmful servers. However, our investigation also highlighted the potential drawbacks associated with unoriginal blocklisting practices and the risk of its misuse. Future work will delve into the broader effects of decentralized moderation tools, including aspects such as segregation, toxicity, and transitivity, contributing to a more comprehensive understanding of content moderation in this evolving field.

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