

Manipulating visibility of political and apolitical threads on Reddit via score boosting

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Abstract— While the phrase ‘Fake News’ has only recently entered the contemporary vernacular, the problem of other fake content such as reviews or opinion articles is and has been pervasive for many years. False articles and reviews have been used to influence purchasers of goods and services in online commercial and review sites, who have responded by removing such articles and reviews. In response, some promoters employ an alternative promotion method where genuine articles and product reviews are exploited using reader voting mechanisms to promote or suppress the visibility of those articles and reviews. This paper measures the effect of vote manipulation on article visibility and user engagement by comparing sets of threads on Reddit whose visibility is artificially increased. The manipulated threads are compared to sets of control threads. The thread sets were selected from two high-activity subreddits: the apolitical AskReddit and the highly-political The_Donald. The results show that vote manipulation has a significant impact on the visibility and on user engagement of the threads on both subreddits. Clearly, remedial action to detect and deny vote manipulation is needed by sites that allow voting by users.

Keywords—Reddit, social media, social manipulation, Reddit score manipulation, politics on social media

I. INTRODUCTION

There are many different forms of social manipulation aimed at convincing consumers to purchase goods or services, or voters to vote in desired ways. This is often done on sites that integrate user-created content or feedback into their visibility and ranking systems, such as online retailers and social media sites. Sometimes this manipulation is done *overtly*, such as with advertisements, and the consumer usually knows that the product promoter has a vested interest in its promotion. At other times, however, the manipulation is done

covertly, with the manipulator concealing their financial or political interests, so as to appear disinterested, and thus more trustworthy. Political parties are less-trusted when using promoted (paid) tweets, [1] which makes it more important to hide self-promotion [2]. Overt manipulation is advertising in the familiar forms where the advertiser does not hide their vested interest, while with covert manipulation, the manipulator hides their vested interest because revealing it would compromise the effectiveness of the manipulation. The concealment of vested interest enables large-scale manipulation to be undetected, as one person can masquerade as numerous different persons, all expressing supportive opinions. A large number of apparent supporters creates a ‘social proof’, essentially an appearance of grass-roots support for their position, a trick exploited widely in online promotion¹.

Covert manipulation for the promotion of products or politics takes a number of forms, such as *astroturfing*, where a single person masquerades as many different people, as well as *shill posting*, where a person posts opinions in social media sites because they are paid to do so. *Hyper-personalisation* (or *microtargeting*) is a form of promotion that is covert in its distribution, because it reveals the promotional information only to the intended targets, who are chosen because of their likely receptivity to the message, thus avoiding any scrutiny of content for accuracy, legality or disclosure of vested interest.

The form of covert manipulation considered in this paper is *vote manipulation*, which is an example of undetected large-scale promotion that engineers a social proof of the value of an article or product review. This, in turn, is a social proof of the value of the reviewed product. Social media sites and review

¹For example, see <https://blog.kissmetrics.com/social-proof/>.

sites allow people to upload opinions and reviews and to comment and rank the opinions and reviews posted by others, such as with “helpful” votes on TripAdvisor and Amazon. These opinions and reviews are valued by other readers who are considering making similar purchases. Thus, there is commercial value for false reviews, such as reviews that praise the promoter’s product or criticise a competitor’s product. The visibility of reviews can be affected, however, by how useful other readers have found those reviews, if readers are able to influence the visibility of reviews by expressing their approval or disapproval of a review, using review ranking or voting mechanisms. Using the same principle as the well-known ‘trust biases’ of Web searches [3], top-ranked reviews receive the greatest exposure and hence have the highest influence, giving highly-ranked reviews an additional commercial value. This is similar to the practice of purchasing followers on Twitter so as to gain the status of ‘influencer’.

Manipulation of voting systems in social media has become valuable to promoters because of tighter controls placed on reviews. For example, Amazon has removed fake reviews and prosecuted their writers, and preventing the posting of reviews except by verified purchasers. Users of TripAdvisor have sued for damages over false reviews [4]. Since promoters cannot place false reviews as easily as before, they now artificially inflate (or reduce) the credibility and visibility of genuine reviews that suit the message they wish to promote, using vote manipulation. Many social media sites allow expressions of approval and, sometimes, disapproval. This can be exploited by a promoter commissioning false upvotes for reviews that positively rate their own products, or false downvotes for reviews that positively rate competitors’ products [5].

It is not only commercial ends being served by vote manipulation, but also political purposes. For example, trainee astroturfers are advised how to upvote movies or documentaries portraying ideas that support a specific political view, and to downvote movies that contradict it; the intention is to ensure that the higher visibility accorded to higher-voted movies will encourage children to access those movies and thus reach impressionable watchers at an early age [2].

Both commercial and political actors see that there is much to be gained from the covert manipulation of consumers and/or voters. This paper seeks to measure that gain in a popular social media site that hosts discussion groups, Reddit. The next section will briefly introduce Reddit.

II. BACKGROUND: REDDIT

This paper investigates the voting system on the social media site Reddit², where users converse and share news, information, and opinions on a range of topics. Reddit calls itself “the front page of the Internet”, promising that “[t]he most interesting content rises to the top” [14], with around 330 million active users per month, 138 thousand active communities [6]. Reddit is currently the sixth most popular website globally [7], putting it on the same level as other social media websites such as Facebook, ranked third [8], and Twitter, ranked twelfth [9].

² <https://www.reddit.com/>

On Reddit, visibility is all-important. Threads are grouped by topic or interest into subreddits and then ranked, with the highest-ranked content being the most visible. The home page is the ‘popular’ subreddit which collates threads from a “large source of diverse content” [10] to create a global top list, with users seeing top threads from their subscribed subreddits.

Although Reddit does have search functionality, it is unlike traditional search engines such as Google which allow searchers to skip directly to a given page of results. There is no similar mechanism on Reddit – users navigate through Reddit’s search results via the ‘prev’ and ‘next’ buttons, one page at a time. This approach extends to navigating subreddits as well, where for a particular navigation tab (such as the newest threads) only the top 25 results are displayed, and the user must click ‘next’ to access the next 25 results, and cannot skip to, say, page 10. Given that one study showed only 10% of people view the second page of a Google search [13], any Reddit thread, regardless of how interesting, on, say, page 150, is unlikely to be seen. As a corollary, any thread, no matter how dull, gains tremendous visibility from being on the front page.

As visibility is so important on Reddit, the algorithms that govern this ranking system are briefly considered. The ‘new’ tab is the easiest to understand as it simply ranks threads to the subreddit via submission time. The ‘top’ tab ranks threads via their total upvote (or ‘karma’) score irrespective of age, to a thread ‘hall of fame’. The ‘hot’ tab is the most interesting because it is both the default tab as well as being a blend of the ‘new’ and ‘top’ tabs, showing the highest upvoted content that is still reasonably new. The algorithm to calculate a thread’s score and rank is no longer available, as Reddit is now closed source [12]. However, archived source code appears to reflect threads scoring and ranking. Slightly altered for readability from the archived source code, the ‘hot’ algorithm is:

```
double hotScore(long upvotes, long downvotes,
double unixdate):
    score = upvotes - downvotes
    scorepoints = log10(max(abs(score), 1))
    if score > 0: sign = 1
    elif score < 0: sign = -1
    else: sign = 0
    timepoints = unixdate - 1134028003
    return round(sign * scorepoints + (timepoints
/ 45000), 7)
```

The ‘hot’ threads are then ranked in descending order of final score. This code shows that the ranking points awarded for the thread’s creation time always increases, as Unix time continuously counts up, so newer threads will always gain more ranking points than older ones, and eventually replace them, thus achieving the newness metric of the ‘hot’ tab. Also, the thread’s score (upvotes minus downvotes) contributes logarithmically to the final score. More detailed descriptions of scoring on Reddit are available [13] and can be seen in the archived Reddit source code³ and in the Reddit wiki⁴.

³ <https://github.com/reddit-archive/reddit/blob/master/r2/r2/lib/d-b/sorts.pyx>

III. RELATED WORK

Covert social media manipulation takes many forms, including the posting of false reviews and opinions and now the manipulation of votes for reviews and opinions. It can be difficult to discover what methods are used by site hosts to detect and manage such manipulation, because secrecy about methods is a necessary part of the battle against manipulation, and these methods are generally not published. Even so, it seems likely that linguistic analysis plays a part in detecting false reviews, as well as user and thread metadata analysis. Some linguistic analysis can identify fake news and other deceptive content by tallying word uses but also by inspecting syntax [15]. Forensic linguistics is useful for detecting when a single writer is masquerading as numerous different people [16]. However forensic linguistics cannot detect vote manipulation since voting requires no text. User metadata analysis may be helpful, such as analysing whether certain accounts habitually up- or downvote reviews for specific products or sellers or how rapidly they vote, although this assumes that voting requires an account on the site. Review metadata can be useful as well, such as whether a disproportionate number of votes have been received by a given review, possibly indicating artificial vote traffic.

Online approval systems are any mechanism which allows the registering and accumulated counting of users' attention to the content of a website. This attention can be recorded neutrally, for example by counting clicks. Alternatively, a positive or negative attitude can also be recorded, as in the case of the upvotes and downvotes on Reddit.

The manipulation of approval systems pre-dates the rise of the current popular social media platforms. Paid Per Click advertising has been plagued by the problem of 'click fraud'. Ads displayed on web pages earn the site owner revenue when the ads are clicked. Click fraud occurs when the site owner generates artificial clicks boost their revenue from ads [17].

Many social media platforms have an approval system. These include Facebook 'likes', Twitter followers, the YouTube view counter, as well as Reddit's upvotes and downvotes. These approval systems have been exploited in one way or another. An underground market exists for services such as 'like farms', which provide fake 'likes' (approvals) to boost the profile of Facebook pages [18]. These fake 'likes' are generated at low cost, and employ a network of accounts to defeat Facebook's fraud detection algorithms [18] [19].

Popularity and influence on Twitter can be increased by the use of fake followers, automated accounts created for that purpose [20]. Fake followers can be purchased by the owner of a Twitter account or can be generated by a third party wishing to increase the influence of an account which serves that third party's agenda. The manipulative use of fake followers is also a problem on Weibo [21] and Instagram [22].

View counts on YouTube indicate the popularity of a video, and popular videos are monetised by having ads displayed with them. The view counter on YouTube can be gamed to artificially boost advertising revenue [15]. There

have been reports that in 2013 YouTube deleted over 2 billion suspected fraudulent views from music industry videos. Despite such efforts, YouTube is still capable of monetising view counts which it has identified as fraudulent [23].

Reddit has implemented vote manipulation defences that include *shadow bans*. Shadow bans aim to deter spam bots by hiding from the user or bot the fact that their threads, votes and comments have been banned [24]. Shadow bans achieve this by displaying votes and comments made by the banned user to themselves and moderators only, so while general users cannot see shadow banned account threads or votes, the banned user does not realise they are not generally visible. Many things can trigger a shadow ban, amongst which are prohibitions on self-promotion [25] and of mass co-ordinated voting ('vote brigading') [26]. The experiment reported in this paper used an external upvoting service, since attempts to create a voting bot resulted in the experimental accounts being shadow banned.

Others have sought to measure the influence of vote manipulation in the Reddit context. Working across the entirety of Reddit, Weninger et al. [27] showed that a single, rapid upvote impacted the final score of a thread by up to 11%, a disproportionately large amount for a single vote. The increase appears to be partly attributable to the immediacy of the upvote (within 60 minutes at most). Their experiment selected over 93,000 threads, randomly assigning a single artificial upvote to one-third of these, a single downvote to the next third, while leaving the remaining third unvoted, as a control group. They implemented a range of upvote latencies between immediate and up to 60 minutes from the time of post. Not only did the upvoted group have a higher final score than the control, but the downvoted group showed a significantly lower final score.

In contrast, McGregor [28] measured the impact of mass upvoting on a single thread, finding that \$200 was sufficient to promote a thread to the front page of Reddit, the position of the highest visibility. This promotion was purportedly achieved through the purchase of many thousands of bot votes. The promotion was short-lived however, as the moderators removed the article, so arguably the visibility purchase was too short-lived to have provided value. The experiment was reported on Reddit and provoked much discussion of methods for detecting bots manipulating votes [29]. Some of the methods proposed included requiring a specific human input such as a clickthrough to be able to vote. Others methods may be less effective, such as limiting the number of votes permitted by any one account. This could be bypassed with bots or vote brigading, even though these go against the accepted behaviour on Reddit generally [30].

There is little research on the manipulation of approval systems. Often the vendors of social media platforms have little or no inclination to collaborate in research and prefer to devote efforts to engineering solutions [19]. Researchers hence need an experimental approach such as in this study of Reddit. This paper bridges the research gap by determining the effects of more modest vote manipulation of a sort that promoters might feasibly engage in, in a political as well as a non-political context. The work considers not just the visibility of voted threads, but also the level of engagement with readers as evidenced by the comments attached to the thread.

⁴ <https://www.reddit.com/wiki/navigation>

IV. EXPERIMENTAL DESIGN

The experiment measured the effect of ten rapid upvotes on a set of 25 recent threads on both a very active political subreddit, The_Donald⁵ and a very active non-political subreddit, AskReddit⁶. It measured the number of user comments and total upvotes that the upvote treatment threads received over a period of 24 hours and compared these to the results of a control set with the same number of randomly-selected, recent threads on the same subreddits. The threads were chosen from The_Donald and AskReddit and allocated alternately into the boosted and control groups, so each subreddit had 25 threads for the upvote treatment group, and 25 for the control group, for a total of 100 threads. The experiment was repeated every 24 hours for 7 days, with each new experiment beginning on completion of the prior experiment, resulting in 168 hours of observation, and 700 threads in total.

The experiment software comprised two components, the first was a set of *nix shell scripts that scraped Reddit website data to select the newest threads, split them into the upvote treatment and control groups, and then scraped the thread data from Reddit to monitor how the threads developed over time, with the relevant comment and upvote extracted for the results. The second component was a third-party service, accessed via API, that provided the upvote treatment to the selected threads.

Threads were scraped every 5 minutes during the first hour, gradually reduced to every 30 minutes from hour 5 to hour 24. This delivered more scrapes during the rapid activity window of a thread early on, and fewer scrapes as the rate of change in upvote and comment counts decreased.

Other than providing the initial upvotes, the experiment did not engage with the thread at all. The threads selected were the 50 newest threads available at the time for each subreddit, irrespective of the title or content. As such, it is possible that threads violating Reddit's rules, or were off-topic for the subreddit they were posted in, were collected. In this case, even if the threads were deleted by Reddit moderators or staff and no longer available for users to access they were not removed from their respective group, and had as much of the upvote treatment applied, if needed, as possible. Any deleted thread remained in its respective group, with the last available thread information used for all subsequent data and calculations.

The metrics applied to the results provided indication of user engagement and thread visibility; these were:

Thread score: the final score of a thread, calculated as the number of upvotes minus the number of downvotes. This metric represents a thread's visibility on Reddit's default 'hot' navigation tab as thread score, along with thread creation time, comprise the thread's ranking; and

Number of user comments: the total number of comments for the thread added by users. While visibility on Reddit is important, user engagement with the content is also a useful measure as it measures how many users were motivated to respond with a reply, rather than just how many viewed it.

⁵ https://www.reddit.com/r/The_Donald/

⁶ <https://www.reddit.com/r/AskReddit>

V. RESULTS

Figure 1 shows the comments of the upvote treatment and control group for all threads, averaged over the 7 experiments, for AskReddit. There is no question as to the effectiveness of the upvote treatment. User engagement of the control threads flat-line almost immediately, while the upvote-treated group experienced a very large, continual increase in user comments.

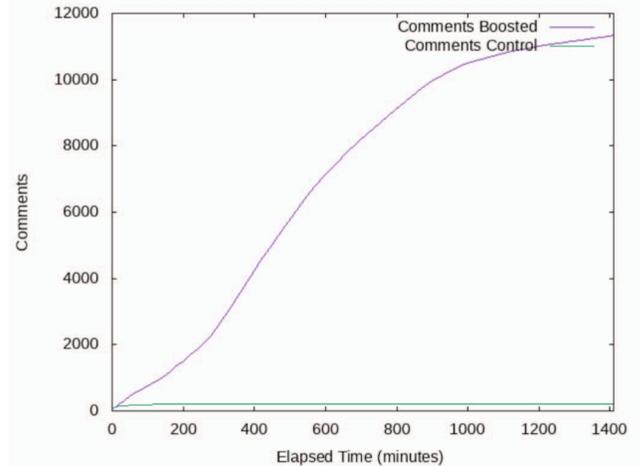


Fig. 1. Average total user comments for 25 upvote treatment threads compared to 25 control threads on AskReddit.

Figure 2 shows that the control group fails to gain any momentum, its threads being quickly buried by Reddit's ranking algorithms. Conversely, the upvote-treated group gets a burst of upvotes which increases their visibility, and which continues as the threads remain highly visible.

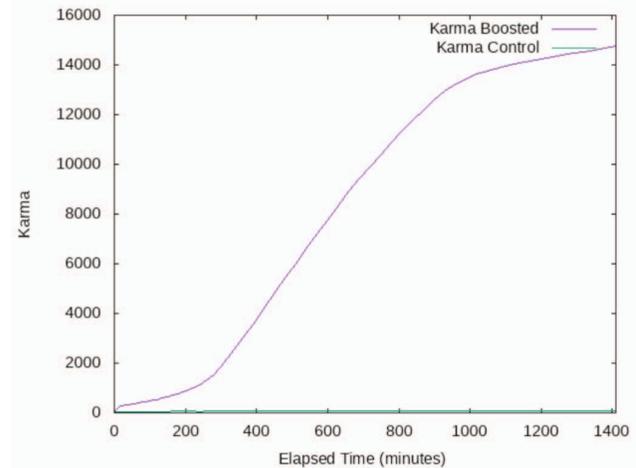


Fig. 2. Average thread score (termed Karma by Reddit) for 25 upvote-treated threads compared to 25 control threads on AskReddit.

In thread scores the best result of the control group is 87, while the worst result from the treatment group is 1346. The control group averaged 67.71, and the upvote-treated group averaged 14495.14.

Table I shows that the initial values between the control and upvote treatment group were very similar, but by the end of the experiments even the best performing control group, with 272 comments, was dwarfed by the worst performing treatment group, with 3002. The average case was 224.71 for the control group and 11331.71 for the treatment group.

Table I shows that while the control group shows little variation between the best and worst performing thread, the upvote-treated group varies widely from a minimum score of 1346 to a best score of 43247, a highly volatile thread score.

TABLE I. A BREAKDOWN OF INITIAL AND FINAL COMMENTS AND SCORE VALUES FOR ASK REDDIT

	Min	Mean	Max
Initial Comments(C ^a)	53	87	108
Initial Comments(T ^b)	51	78.57	122
Final Comments(C ^c)	178	224.71	272
Final Comments(T ^b)	3002	11331.71	26393
Initial Score(C ^a)	27	38.43	54
Initial Score(T ^b)	31	41.86	68
Final Score(C ^a)	32	67.71	87
Final Score(T ^b)	1596	14745.14	43497
Corrected Final Score (T ^{bc})	1346	14495.14	43247

a. Control group

b. Upvote treatment group

c. Score corrected for upvote treatment

Figure 3 shows that although comments for the upvote-treated group performs better than the control group, the results are far less disparate than on AskReddit.

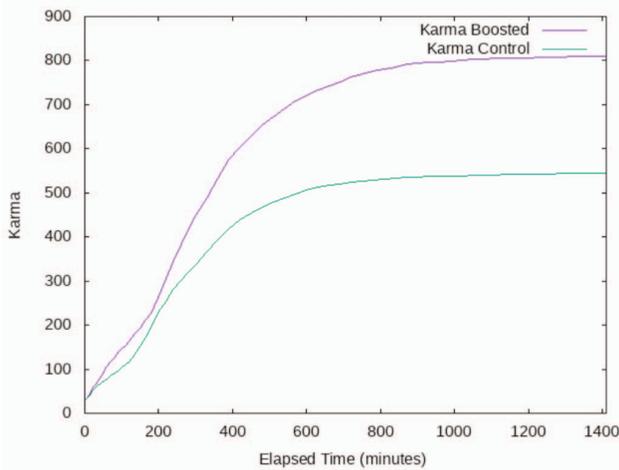


Fig. 3. Average total user comments for 25 upvote treatment threads compared to 25 control threads on The_Donald.

Unlike AskReddit, where the control group received almost no comments, the control groups fare well on The_Donald. Furthermore, while comment scores for both the control and upvote-treated groups were much larger than the control group on AskReddit, neither score comes close to the comment count

displayed by the AskReddit upvote-treated group. Figure 4 shows the similar results on The_Donald for score values.

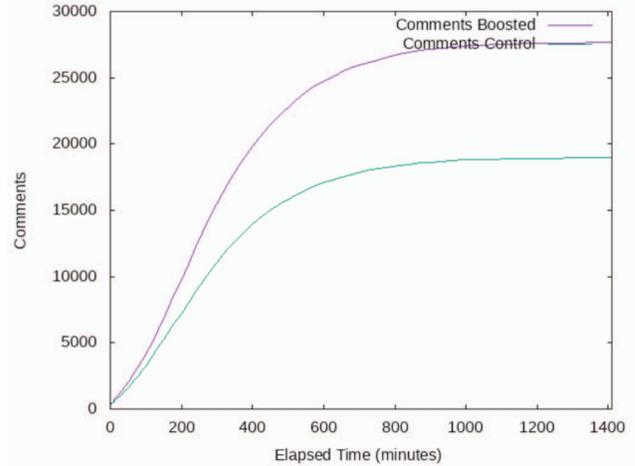


Fig. 4. Average thread score (termed Karma by Reddit) for 25 upvote treatment threads compared to 25 control threads on The_Donald

Even though the upvote-treated groups come out ahead, the control group performs far in excess of the AskReddit control group. Both the control and upvote-treated groups on The_Donald eclipse the upvote-treated group scores on AskReddit. This is less intuitive, given that the comment scores on The_Donald were relatively low when compared to AskReddit's upvote-treated comments. Table II provides more insight into the graphs. Minimum thread scores are much higher on The_Donald (369.86 control, 319.14 treated) than on AskReddit (38.43 control, 41.86 treated). The 250 total upvote treatment would have been substantially less effective on The_Donald because of the prior thread scores. For some threads, the control group averaged 544.71 comments, whilst the upvoted group averaged 810.29, a 48.76% increase. Both treatment and control group comments scores on The_Donald were much lower than AskReddit's comment treatment group, which averaged a comment count of 11331.71.

TABLE II. A BREAKDOWN OF INITIAL AND FINAL COMMENTS AND SCORE VALUES FOR THE_DONALD

	Min	Mean	Max
Initial Comments(C ^d)	13	28.86	55
Initial Comments(T ^e)	13	28.29	50
Final Comments(C ^d)	175	544.71	993
Final Comments(T ^e)	286	810.29	1539
Initial Score(C ^d)	147	369.86	750
Initial Score(T ^e)	149	319.14	639
Final Score(C ^d)	7446	18976	38521
Final Score(T ^e)	16302	27675.15	48226
Corrected Final Score (T ^{ef})	16052	27425.15	47976

d. Control group

e. Upvote treatment group

f. Score corrected for upvote treatment

The scores for `The_Donald` are similar, where the best result for the control group is 38521, whilst the worst performing treatment group is 16052, indicating the upvote treatment was not more effective in all circumstances, in contrast to the AskReddit score results. The control group averages 18976, and the upvoted group averages 27675.15 after correction, for an average increase of 45.84% for the upvoted group, mirroring the comment result.

Similar to the AskReddit results, there is volatility in `The_Donald` results, with the worst performing upvoted group scoring 16052, while the best received 47976, a range of 31924. Unlike the AskReddit set, the upvoted group was not more successful than the control group in all experiments.

VI. DISCUSSION

A. The effect of upvote treatment

The main finding from this experiment is that the upvote treatment proved to be effective on the thread participation metrics for both the political and non-political subreddits. The results were less extreme on `The_Donald`. It may be that because of `The_Donald`'s high initial thread score the upvote treatment, owing to the logarithmic effect of score when contributing to thread rank, was diminished, and was less effective. The reason for `The_Donald`'s high initial scores is not known, however "cultural" differences between AskReddit and `The_Donald` may be partly responsible. AskReddit has a relatively higher comment count compared to `The_Donald`, but `The_Donald` has a higher relative upvote count compared to AskReddit. This may be because AskReddit threads are generally phrased as an open-ended question, and users are more likely to interact with threads by writing a comment addressing the question. In contrast, `The_Donald` users are more likely to interact with threads by upvoting content like rather than commenting. This behaviour is reinforced by the design of `The_Donald`, which has no downvote option as on most subreddits but only shows an upvote graphic.

B. Observations regarding purchased artificial upvotes

During this experiment, the upvoting API took between 15 minutes to 1 hour to report having delivered all upvotes. This delay reduces the consistency of the results. For example, in a thread's "hot" ranking, an upvote when used on a thread with a score of 1 (the default for submission), 10 upvotes will increase the thread's ranking points by just 0.0414. This is because $\max(\log_{10}(1), 1)$ evaluates to 1, whilst $\max(\log_{10}(11), 1)$ evaluates to ~ 1.0414 . However, the other half of the equation, which is derived from the $\text{UnixEpoch}/45000$, means that newly created threads gain 0.08 points each hour they were submitted after the upvote. So if a thread received its upvotes more than $(0.0414 * 45000) / 60$, or 31.05 minutes after creation, it would have no ranking advantage over a new thread with 1 upvote.

The upvoting delay is due to human effort. Numerous sites sell online tasks performed by humans, in the same tradition as Amazon's Mechanical Turk services [31], such as the 50-cent party [32] and the Internet Water Army [33]. This manual labour explains the site's claimed 100% success in evading Reddit's anti-bot software.

C. Discussion on number of upvotes used for treatment

A relatively low number of upvotes was given to each thread to minimise the time taken and to avoid intervention by Reddit's moderators for threads that had obviously been tampered with. However, as discussed above, because the Reddit algorithm uses $\max(\log_{10}(x), 1)$ any upvote count 10 or less will return 1. This means for threads with upvote counts close to the initial value of 1, much of the upvote treatment is "wasted", and future work may wish to consider altering the number of upvotes given to see which is the most effective.

D. Observations regarding thread volatility

The experiment was run 7 times using 50 threads each time. There was a wide range of thread popularity, and many factors might influence whether threads become popular or not. Further work in this area should repeat the experiment more times to allow useful calculations for median, standard deviation and so forth to occur so that outliers can be better identified and accounted for. However increasing the thread count should be avoided as it increases the minimum and maximum age of a thread, which in turn increases the impact of the newness aspect and decreases the impact of the thread score in the hot ranking algorithm.

E. Discussion of subreddit selection

Threads were selected from two highly-active subreddits, AskReddit and `The_Donald`, to contrast between an apolitical and political environment. Smaller or niche subreddits might be more sensitive to thread quality compared to "low effort" subreddits, e.g., the 'Data Is Beautiful' subreddit has low activity, with few new threads per hour, so the 50 newest threads would span well over 24 hours by which time the upvote treatment would be ineffective. By contrast, AskReddit has hundreds of threads per hour, and requires only a question such as: "Reddit, what is your craziest college dorm room story?". `The_Donald` is also a subreddit with high activity where the newest 50 threads are generally less than 1 hour old.

VII. CONCLUSION

This paper investigated the effect of manipulating the visibility of non-political and political threads on Reddit by artificially inflating the score of new threads on the AskReddit and `The_Donald` subreddits. Each experiment artificially upvoted 25 threads and compared them to 25 control threads over 24 hours to determine the impact of the score inflation on thread visibility and thread engagement. The experiment was run 7 times to average the results. The results found that for AskReddit, upvote-treated threads received 4942.82% more comments than the control, and a 21307.68% higher final score. `The_Donald` on the other hand showed less exaggerated but still impressive results with upvote-treated threads receiving 48.76% more comments than the control, and a 45.84% higher final score. The results were less remarkable on `The_Donald` since threads tended to have higher initial scores than AskReddit, so the upvote treatment had less impact on the visibility of threads. This discrepancy in higher initial thread scores may be due to the cultural differences between the AskReddit and `The_Donald` subreddits. Given the limited number of artificial upvotes on threads, there is a real and

substantial increase in thread participation and thread visibility. The results show that even modest artificial upvoting significantly impacts the final score of the thread, extending the prior work where only a single vote was used. It also supports prior results where a single thread was massively upvoted to get it on the Reddit front page. The selection of 10 votes was based on the Reddit logarithmic scale for upvoting, giving a high degree of impact for moderate cost. The results show that product promoters or those with a political agenda have easy access to an effective and inexpensive means to covertly manipulate Reddit thread votes with large boosts in visibility and thread interaction. For an average cost of \$1 per thread, clearly product promoters or political actors would be tempted to game Reddit's upvoting mechanisms.

Future work will increase the length of the study. The results obtained indicate a very high volatility between the best performing and worst performing threads on both subreddits in both the control and treatment groups and this source of potential error could be addressed by running the experiment over a longer duration. Furthermore, the differences in treatment effectiveness observed between AskReddit and The_Donald suggest it would be worthwhile conducting a similar experiment on other subreddits. Finally, future work may also alter the number of upvotes to determine how the quantity correlates to both visibility and engagement.

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