

# Use of Hashtags related to Covid-19 infodemics by bot accounts

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## Introduction

This work aims to analyze how social bots use hashtags compared to users on topics related to misinformation during the outbreak of the Covid-19 pandemic. We selected tweets on specific topics related to infodemics: vaccines, hydroxychloroquine, military, conspiracy, laboratory, Bill Gates, 5G, and UV. We build a network based on the co-occurrence of hashtags. We determined the use of hashtags based on the source (bot or nonbot). Finally, with the objective of finding different patterns of hashtag usage, we applied network analysis. This way, we analyzed how bots used hashtags and compared them with real users.

In addition, we computed different metrics of connection, distribution, and segmentation of the hashtag network. We computed each metric separately considering whether the hashtags appear in Tweets posted by a bot or a nonbot. We used the PageRank algorithm to identify the most important nodes in the network [1]. We also used the degree value, which is the number of connections each hashtag has, and we used the betweenness, as a measure of centrality [2]. In addition, we used Louvain's algorithm to detect the most important communities in our networks. The Louvain method is an algorithm to detect communities in large networks. It maximizes a modularity score for each community, where the modularity quantifies the quality of an assignment of nodes to communities. In this way, we can extract those hashtags that usually co-occur together.

## Results

Most accounts (85.2%) were normal users (i.e. nonbots). 14.8% of the tweets were classified with a high likelihood of being bot accounts. Finally, based on our list of topics, we extracted 107K Tweets between March and July 2022. Most tweets were related to vaccines (55.1%, 59,090/107,173), hydroxychloroquine (16.5%, 17,731/107,173), or military (11.5%, 12,548/107,173). If we look at the distribution of topics by account type (Figure 1), there are significant differences ( $p < .001$ ). Nonbots have a higher percentage of tweets mentioning vaccines, conspiracy, laboratory, or 5G. In contrast, bots posted more about hydroxychloroquine, the military, Bill Gates, and UV. In addition to the differences in distribution, it is worth noting the presence of so many bots on critical public health and pandemic topics, such as vaccines or hydroxychloroquine.

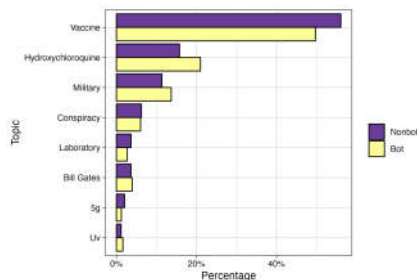


Figure 1. Distribution of bots and nonbots by topic.

Figure 2 contains the entire network of hashtags. Following the proposed methodology, we have drawn the hashtags co-occurrence network. Then we coloured the Louvain Communities. As an example, we pointed out some hashtags representing the different themes analyzed in this work.

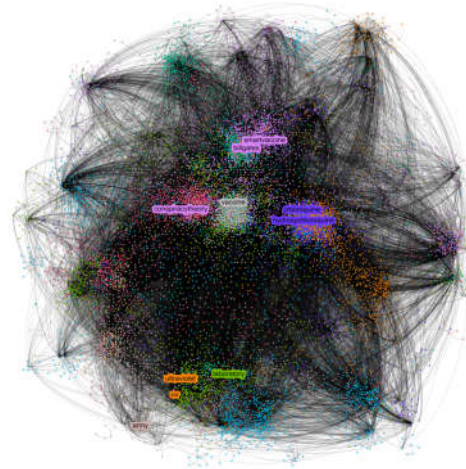


Figure 2. Hashtag network.

Next, we analyzed the hashtags network according to the type of account that posted the message. There are a few differences in the top-used hashtags between both communities. Thus, hashtags such as Trump, China, or Billgates appear in both groups. However, the hashtag vaccineswork is one of the most used by the nonbots; also, the hashtag lka, which is the country code of Sri Lanka, in the case of the bots.

### Vaccines

The most common co-occurrent hashtags used by nonbots regarding vaccines are uk - usa, research - science, vaccineswork - worldimmunizationweek. However, the most common hashtags in those tweets posted by bots are trump - votebluetosaveamerica, healthcare - ppe, or even healthcare - ventilators. In addition, these last mentioned are exclusive of bots. That is, they only co-occur in tweets from accounts classified as bots. Besides, it is worth mentioning that #billgates, along with #pandemic or #china, are the hashtags with the highest degree of connections.

### Hydroxychloroquine

Hashtags related to Trump and the Republican movement were common in the case of hydroxychloroquine. These hashtags, such as #kag, #maga, #gop, #qanon, and #tcot were more common in bot tweets. Although #trump also appears in the case of nonbots, there were other hashtags related to news: #breaking-#breakingnews, #chinavirus-#wuhonavirus. Consequently, #trump has the highest degree of connection and the one with the highest betweenness. This hashtag, along with #chloroquine or #coronaviruspandemic, is the hashtag with the highest number of connections. There is a big difference between the first and the rest of the hashtags shown in Table 2. This difference indicates the leading role that #trump plays in the conversation about hydroxychloroquine.

### Military

In this case, hashtags are related to countries. For nonbots, those most mentioned are #china - #us, #italy - #russia, #lka - #srilanka. The latter is the most common among Bots, followed in fourth place by (#italy - #russia). Among the sets that do not mention countries, we find hashtags related to Trump (#gop - #trump, #kag - #maga, #kag - #qanon).

### Discussion

The analysis of hashtags provides several direct findings regarding attitudes towards Covid and associated behaviours. There were consistent differences between bots and nonbots. In the case of bots, it is more common to find co-occurrence of hashtags related to political movements, generally right-wing and Trump-related. This is in line with findings present in the literature where the higher presence of conservatives in topics related to misinformation during covid has been demonstrated [41]. Although the number of bots was relatively minor concerning the number of nonbots, through the classification of tweets, we identified the topics with a higher predominance of bots, such as hydroxychloroquine, military, Bill Gates, and UV.

### Conclusions

The presence of bots varies according to the topic. This method has been able to identify different patterns of hashtag use according to the type of account. Bots, for example, tend to tag messages with political movements or use hashtags related to other fake news issues. On the contrary, nonbots accounts use hashtags related to countries or geographical areas. In addition, the use of communities to group hashtag co-occurrences has found differences in the distribution of bots and nonbots. This method helps flag hashtags potentially related to fake news or misinformation. Along the same line, these findings may prove helpful in addressing the spread of health misinformation on social networks.

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