

University of Copenhagen
Department of Political Science
Social Network Analysis (ASTK18106U)
Yevgeniy Golovchenko

Structure and Strategy of the Internet Research Agency on Twitter

Ole Fechner, Johannes Kopf

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Boddinstr. 15
12053 Berlin
ole.fechner@fu-berlin.de

MA Political Science

Moselstr. 50
50674 Cologne
jkopf@posteo.de

MA Political Science

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1 Introduction

2 Agenda-building and Astroturfing

The process of trying to move an actors agenda to the agenda of other actor's, especially policymakers, is defined as *agenda-building* (Linvill/Warren 2018: 3). This can also be extended to the question of how the public views certain issues, usually by analyzing media coverage of those issues: "Agenda-building research examines how certain groups, such as those in politics and business, influence what issues journalists cover as well as how the public views issues" (Parmelee 2014: 434). Since the rise of social media platforms like Twitter and Facebook, agenda-building takes place in those environments. This is due to journalists drawing heavily on Twitter for their job and, on the other hand, research shows that Twitter is the most popular social media platform for participating in political discussions, which from there are often taken to other media (Parmelee 2014: 435, 437). Influencing the citizens of another country through the use of media is nothing new, rather it is regularly used in conflicts or during war. "However, Russia's work on social media has taken agenda-building efforts by nations into a new context" (Linvill/Warren 2018: 3).

Closely linked to agenda-building is a second phenomenon called (political or/and on-line) *astroturfing*, which can be characterized as the "creation of a false or exaggerated impression of grassroots support" (Harcup 2014). It describes the strategic and coordinated approach of a group with the aim to create the impression of a certain public opinion, that might not exist in that way. On social media, those groups use many different accounts that post and interact with regular users to create the desired impression. For the purpose of this paper, we see astroturfing as a strategy of agenda-building. The anonymity provided by platforms like Twitter, as well as the covert structure of those groups, make them very hard to discover (Yang et al. 2017: 564). This exploratory study will therefore take the structure of the IRA as a starting point, instead of the presumed agenda behind the organization. Social network analysis, which will be introduced in the next section, offers an excellent tool box to conduct this task.

3 Social Network Analysis of the IRA Retweet Network

To analyze the structure and possible strategies of the IRA, we will take social network analysis (SNA) as the method of choice. The data-driven character of SNA – the notion of people relating to each other, and the significance put into the structure and strength

of those relations being almost the only one (Golovchenko et al. 2018: 982) – makes it especially viable for our exploratory approach. SNA conceptualizes the linkages between actors as “channels for transfer or ‘flow’ of resources”, while the actors themselves are seen as “interdependent rather than independent, autonomous units” (Wasserman/Faust 1994: 4). Therefore, the different actor attributes are seen as emerging out of their relations and not vice versa, as in most other quantitative analyses (Wasserman/Faust 1994: 8). This allows us to ignore the question of the actual people behind different accounts and tell something about the IRA and its structure, as well as its strategy, as a whole. The most important relation to analyze how the IRA uses astroturfing as a strategy for agenda-building is the distribution of information, in this case via retweets. Accordingly, the foundation of this paper will be a social network consisting of Twitter accounts as nodes and retweets as edges (or linkages).

3.1 Data: An Ego-Centered Retweet Network

We will use a dataset, published by NBC News (2018), consisting of 203,451 Tweets by 453 accounts between July 2014 and September 2017, which were linked to the IRA by an official document handed over to US Congress by Twitter. Twitter justifies this linking by referring to “third party sources”, which makes it impossible to reconstruct or evaluate their method. Therefore, we have to assume those accounts’ links to the IRA to be correct, as it is the best evaluation available.

To create the social network, we need to clean the data: First, we drop any of the tweets that are not retweets, which leaves us with 147,428 retweets by 453 troll accounts. Second, 120 trolls, who did not retweet at all, were dropped accordingly. Our dataset now consists a set of 333 unique troll Twitter handles¹, who are retweeting others. A variable stating the unique User ID is used to validate uniqueness of the users, showing that there are indeed no duplicate User IDs in the dataset. Since, we only have information about who these 333 accounts did retweet, but not by whom they were retweeted, the network is ego-centered around the group of 333 trolls. Of these 333 trolls, 151 (ca 45%) retweeted others and were themselves retweeted by other trolls, thus being both sender and receiver. 182 (ca 55%) trolls only retweeted others, but were not retweeted themselves, making them only senders.² A third group of 71 trolls was found by looking at who was retweeted by the original group of trolls in the data, thus increasing the number of trolls in our data to a group

¹A Twitter handle is the screen name of a Twitter account that can be changed by the users.

²We define a retweet sender as the person retweeting an original Tweet by another person, who, accordingly, is the retweet receiver.

of 404. These 71 trolls were retweeted by others, though did not send retweets themselves. Finally, the big body of users in the dataset consists of 36,485 users, who are retweeted by the trolls, but are not themselves categorized as trolls by Twitter. Table 1 gives a first overview over our dataset. Overall, there are 36,889 unique twitter users in the dataset, 404 classified trolls and 36,485 non-trolls. The retweets contain relational information about one user retweeting another, therefore creating a directional edge between the two. Thus, the graph is a directed, ego-centered network of 404 IRA accounts with 36,889 unique Twitter accounts as nodes and edges representing retweets from the sender to the receiver.

User	N	Senders	Receivers
Troll	404	333	222
Non-Troll	36,485	0	36,485
Total	36,889	333	36,707

Table 1: User Statistics

To further extend our data and our scope of analysis, we are adding additional qualitative information on the IRA trolls, provided by Darren Linvill and Patrick Lee Warren (2018) via the online news outlet FiveThirtyEight (citation). Linvill and Warren conduct a qualitative analysis, categorizing a sample of 1,133 IRA troll accounts by examining the tweet content and the account names, applying a temporal analysis of the trolls tweeting behavior after. They “identified five categories of IRA-associated Twitter handles, each with unique patterns of behaviors: *Right Troll*, *Left Troll*, *Newsfeed*, *Hashtag Gamer*, and *Fearmonger*.” (Linvill/Warren 2018: 6). In addition, there are three categories, which are not used within their analysis, those being *Non-English*, *Commercial* and *Unknown*. The categories *Right Troll* and *Left Troll* need little explanation, as they include users who broadcasted right-leaning populist and socially liberal messages. *Hashtag Gamers* are users who are playing word games on Twitter, mostly non-political, though sometimes including left- or right-leaning messages. *Newsfeed* Trolls are posing as local US News Agencies, mostly linking to legitimate news content, often with a pro-Russian perspective. *Fearmongers* spread news of crisis events such as Tweets about salmonella infections. The *Non-English* troll category includes users who tweeted in other languages than English, predominately Russian, some German and little French and Spanish. *Commercial* Trolls are not included in our dataset. Finally, users were categorized as *Unknown*, if they could not be assigned to other categories for lack of information in their tweets. These categories will be included in this paper’s analysis, since might be interesting to see how they interact with the other trolls.

We are appending Linvill and Warren’s account categories to our data, finding categories are available for 394 of the 404 troll handles in our dataset, meaning that around 98% of the trolls in our dataset are categorized. Table 2 shows the distribution of the categories among our dataset.

Category	N	Senders	Receivers	Average_Followers
Right	101	75	90	4649
Left	110	104	48	1783
Hashtag Gamer	61	43	60	3021
Non-English	106	100	7	2127
Newsfeed	11	1	10	16446
Fearmonger	4	0	4	0
Unknown	11	10	3	3306
Total	404	333	222	4476

Table 2: Troll Statistics

As another attribute, we are appending information on the count of followers of the troll accounts from a second dataset provided by NBC news. The information on the count of followers provided only includes one figure and does not vary over time, without specification of when these follower counts were obtained. We will assume that they are at least to some degree representative and use them as a heuristic. Table 2 gives the average number of followers for each account category.

Lastly, we are using the full time period of retweets, from July 2014 to September 2017. This paper is not interested in a time period preceding a specific event, like an election or a specific trending discussion, but rather strategic behavior of the trolls in general. That is why it seems to be the right approach to include all of the Tweets in the analysis.

3.2 Methods

To understand the IRA’s division of labor between the accounts, we begin with testing whether Linvill and Warren’s qualitative findings of the different account types would be reproducible via using network properties. For this, we will draw on a community detection algorithm based on modularity, known as the Louvain Method (Blondel et al. 2008).³ Communities are mesoscopic structures of a graph, that consist “of a group of nodes that

³For our network, this algorithm produced the best results. The Infomap algorithm (cf. Rosvall/Bergstrom 2008) results in one big community containing ca 98% of the nodes.

are relatively densely connected to each other but sparsely connected to other dense groups in the network” (Porter et al. 2009: 1083). The Louvain algorithm is based on modularity, “a scalar value between -1 and 1 that measures the density of links inside communities as compared to links between communities” (Blondel et al. 2008: 2; cf. also Porter et al. 2009: 1089). It approximately maximizes the modularity for each node, thus identifying communities. Finally we will compare the communities with Linvill and Warren’s account types, to see weather we can better understand the identified community structure.

One important measure for the cooperation of the accounts is graph density, the proportion of all possible edges that are present in the graph (Wasserman/Faust 1994: 101). Since the network is ego-centered, it only makes sense to calculate density for the troll subgraph. We will then compare densities of the different communities, which can give an indication weather the IRA has distinctive strategies for those groups. Following Wassermann and Faust (1994: 102) we calculate the density of the different community subgraphs Δ_c as:

$$\Delta_c = \frac{2L_c}{g_c(g_c - 1)},$$

where L_c is the number of edges present in the community subgraph, and g_c is the number of nodes in said graph. In communities with higher density, the accounts are working more together, meaning they spread information further through retweeting, while accounts in less dense communities rely more on information they put into the network themselves.

Identifying the most important accounts helps to understand the structure of the IRA. Operationalizing importance in SNA is usually done through centrality and prestige indices, whereas not only the chosen actors are considered prestigious, but also those doing the choosing (Wasserman/Faust 1994: 170). Since the network is ego-centered around the troll accounts, the indices have limited reach in their interpretation, but still deliver important insights. To show the most central accounts, we will calculate outdegree. The index can only be computed for IRA accounts, since they are the only retweeting in our dataset. We will calculate the outdegree weighted and unweighted respectively, the former results in the accounts that retweet the majority of different accounts, the latter in those retweeting the most.⁴ The outdegree of a node $d_{out}(n_i)$ is computed as

$$d_{out}(n_i) = \sum_j x_{ij},$$

⁴A weighted graph is a graph in which each edge carries a value (Wasserman/Faust 1994: 140), in this case the number of retweets between two accounts. In an unweighted graph, each edge has the value 1.

where x_{ij} is an edge from i to j (cf. Wasserman/Faust 1994: 178. For the weighted outdegree x_{ij} is multiplied by the value of the edge. Prestige, on the other hand, will be calculated through indegree, which results in those accounts retweeted the most and can therefore tell about what accounts the IRA draws on. It will also be computed for the weighted and unweighted graph separately, which shows the accounts retweeted by the majority of different accounts and those retweeted the most in general respectively. The indegree of a node $d_{in}(n_i)$ is computed simply as

$$d_{in}(n_i) = \sum_j x_{ji},$$

where x_{ji} is an edge from j to i (cf. Wasserman/Faust 1994: 202. For the weighted outdegree x_{ji} is multiplied by the value of the edge.

Finally, we will look at the most engaged users in the network to identify the so-called super-spreaders of information. In SNA, the ability to spread information better than other individuals is ascribed to their unique location in the network, which makes identifying those a prime task of analyzing networks used for false information (Pei et al. 2015: 1). Pei et al. (2015) show that, compared to other approaches, the k-core method predicts the super-spreaders most accurately. “A k-core is a maximal subset of the network where all nodes are connected to at least ‘k’ number of other nodes: so ‘k’ can be any whole number” (Golovchenko et al. 2018: 983). Hence, the k-core specifies a subgraph via the number of ties that must be present between nodes, it is based on the nodal degree. We can define a subgraph G_s as a k-core if

$$d_s(i) \geq k \text{ for all } n_i \in N_s,$$

where $d_s(i)$ is the (in-)degree of node i and N_s the set of nodes in the subgraph (Wasserman/Faust 1994: 266). Once again, the network being ego-centered limits the validity of the results, since every non-troll in reality has a higher degree through retweets from other non-troll accounts and retweeting themselves. We can therefore only identify the most important IRA accounts regarding their own network. To account for this, we will also compute the k-in-core through the indegrees. The idea is that information from one account is spread quickly, if this account is retweeted a lot and the accounts retweeting it also get retweeted a lot.

4 Analysis

In the preceding chapter, the data and methods that form the basis of our analysis have been introduced. Figure 1 shows the entire retweet network consisting of three main clusters. We will focus our analysis on those clusters in four steps. First, the results of the modularity community detection algorithm are illustrated and new communities are established, based on our findings, as well as the qualitative coding of Linvill and Warren. Second, graph densities are compared between these communities. Third, degree centrality indices are analyzed for the whole graph to identify the most active IRA accounts and the most prestigious accounts. Finally, we will take a look at the k-cores, to detect information super-spreaders and the connectedness between the clusters. In the last section, we then discuss the findings regarding the strategy and structure of the IRA.

4.1 Results

We run a modularity-based community detection, following the Louvain Method (Blondel et al. 2008). Figure 1 shows the distribution of algorithm communities among the qualitative account categories created by Linvill/Warren (2018). For further analysis, we want to rely on communities that were computed with the Louvain Method, since they originate from the structure of ties within our dataset and this appears to be more consistent with the overall method of SNA. To not exceed the scope of this paper, we narrow down our analysis by merging all minor communities below an arbitrary threshold of 50 nodes, since they presumably bear more risk of yielding unrepresentative findings. We then apply the qualitative categorization to our newly distincted communities. In Figure 1, we see that some categories overlap strongly with distinct communities, whereas other categories show a rather mixed composition in our data. 94% of the left troll category is captured with one community, which will be our new left troll community. The hashtager community is 90% captured by one community, which will be our new hashtager troll community. 90% of the right troll category consist of two major communities with shares of 52% and 38%, which we merge to one new right troll community. We justify this merger by arguing that these two communities could represent distinct right-wing groups underneath a general right-wing community (e.g. Conspiracy Theorist vs. Alt Right User). (Kaiser/Rauchfleisch 2018). We argue, that for these categories, which are overlapping with at least 90%, there is sufficient congruence to continue using the qualitative attributes. The non-english troll category consists of multiple communities, with a biggest community share of 27%. Non of the non-english or other categories passes our threshold community size of 50, which

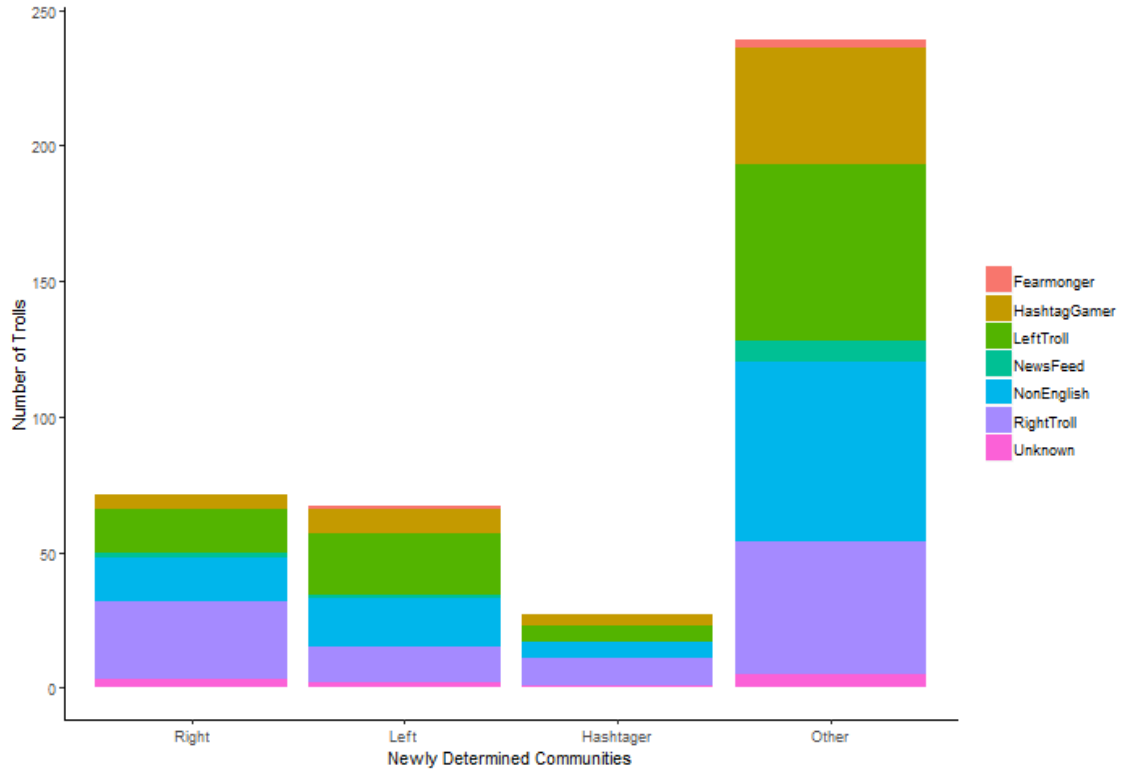


Figure 2: Distribution of account categories among communities detected by the Louvain Method. Color reflects account categories by Linvill/Warren

communities. Figure 3 shows the graph densities for the three communities for both directed and undirected versions of each subgraph. As a mode for creating an undirected graph from a directed one, we chose too keep a tie for every relationship that is only defined with a single directional tie, but also to collapse all reciprocal ties into one tie in the undirected graph. This avoids having multiple ties in one relationship. First of all, we see that the undirected subgraphs' densities are approximately twice as high as directed ones, with only minor deficits. With our mode of creating an undirected graph, we can interpret this that way, that there are not many reciprocal ties in the subgraphs. If there was a considerable amount of reciprocal ties, they would cause a higher density of the directed subgraph in comparison to the undirected one ($>50\%$).

Examining the magnitude of densities across different community subgraphs, we find that the hashtager community is the most dense by a significant margin. Approximately 17.7% of all possible ties are present for the undirected subgraph. This could relate to the nature of this community. As laid out above, hashtag gamers retweet themselves playing a word game, which means that it appears to constitute this community's cohesion to retweet one another frequently. Right trolls have the second largest density with 7.4%, which is more

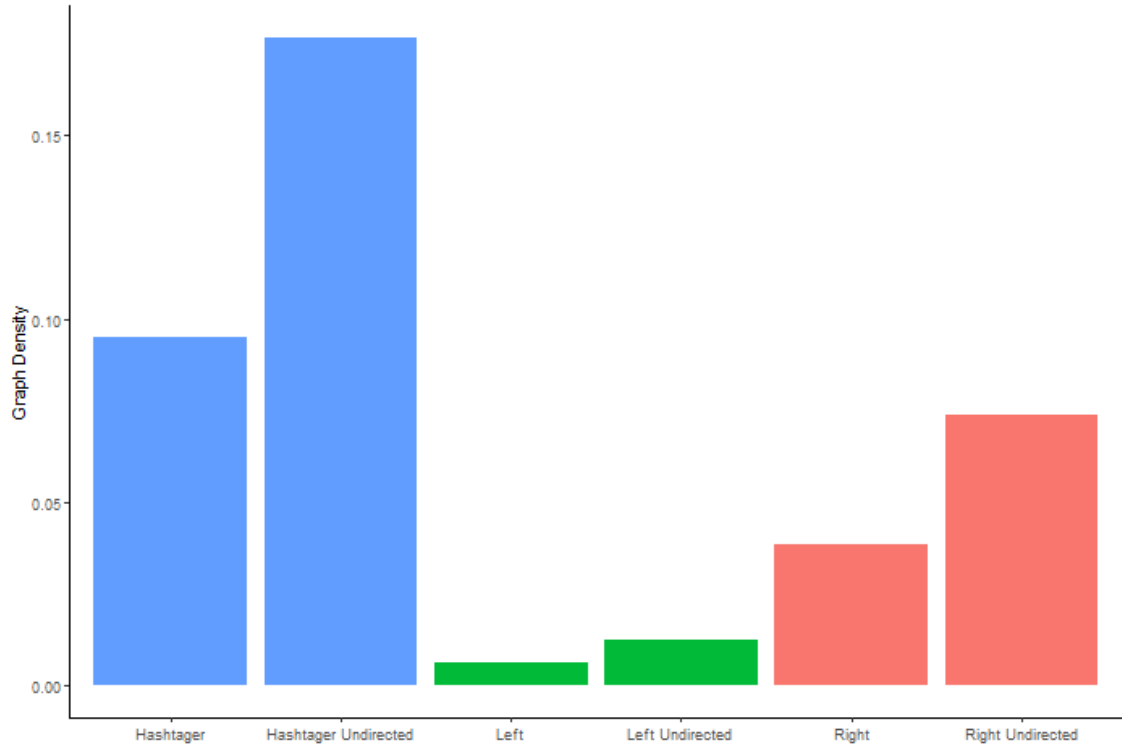


Figure 3: Graph densities in the three biggest communities.

than six times larger than the left community’s density of 1.2%, looking at the numbers for the undirected graphs.

We now analyze the degree centrality of our graph. We start with the outdegree, which we use as a measure for centrality and the weighted outdegree, which gives additional information on the activity of the user. Because of our network is ego-centered around the central group of trolls, only troll accounts have outdegrees. Table 3 shows the top 10 users ranked by outdegree.

The first ranked user *ameliebaldwin* really sticks out with an outdegree of 4,896, meaning that the user retweeted nearly 5,000 different users. The weighted outdegree of *ameliebaldwin* is 9,243, which includes multiple retweets of the same user. Since the weighted outdegree is significantly higher than the unweighted one, this means that *ameliebaldwin* retweeted a large number of users only a few times, rather than retweeting the same small number of users over and over again. The category and community allocation disagree for *ameliebaldwin*. While the qualitative analysis by Linvill/Warren 2018 found the user to be a right troll, the community detection algorithm did not find it to belong one of the major right troll communities. This exact pattern of disagreement reappears for three other users in Table 3. Subsequent to *ameliebaldwin*, there is a group of accounts retweeting

User	Community	Category	Followers	$d_{out}(n_i)$	$d_{out}(n_i)$ weighted
ameliebaldwin	Left	RightTroll	2,464	4,896	9,243
patriotblake	Left	RightTroll	2,035	2,856	4,106
hyddrox	Other	RightTroll	2,225	2,650	6,788
giselleevns	Other	Unknown	24,344	2,282	5,403
cookncooks	Right	RightTroll	1,468	2,153	2,893
emileewaren	Hashtager	RightTroll	1,909	2,116	2,891
dorothiebell	Other	RightTroll	1,893	2,010	2,874
baobaeham	Left	LeftTroll	1,032	1,802	3,215
michellearry	Other	RightTroll	3,229	1,611	2,677
nickluna	Right	RightTroll	1,457	1,597	2,825

Table 3: Top 10 users ranked by outdegree

more than 2,000 different users, which is mainly dominated by right trolls following the categorization, but also with partial disagreement, following the above-mentioned pattern. The fourth ranked user *giselleevns* sticks out for having the most followers in the ranking with 24,344. With a mean number of followers of 3,022 and a maximum of 61,109, *giselleevns* appears to be one of the most followed accounts in the dataset. Though, it needs to be noted, that information on followers is only available for troll accounts in our dataset. Contrary to the mostly right troll dominated top ten ranked outdegree users, *giselleevns* was allocated to the hashtager community, with disagreement of Linvill/Warren 2018, who could not attribute the account to a category. When ranking the account for weighted outdegree, as can be seen in Table 4, the picture slightly changes. While some accounts like *ameliebaldwin* and *giselleevns* remain in high-ranked positions, six left troll accounts are now in the ranking, for which category and community allocation mostly agrees.

The highest ranked left troll account *mrcldepratt* has a weighted outdegree of 3,262 and an unweighted one of 914. Compared to the top ranked presumably right troll accounts, the left troll accounts approximately only have a maximum of half of the unweighted outdegree, but are much closer on the wheighted outdegree. This means that the left trolls retweet a smaller number of accounts more often than right trolls do. This relates to the lower graph density for the left troll community that was computed above.

When examining the accounts with the highest indegrees, contrary to outdegree, both trolls and non-troll accounts are included. We use indegree as a measure for prestige, as it shows how often a user is chosen to be retweeted by the trolls. Table 5 shows the ten highest ranked accounts for unweighted indegree. Here, mostly non-troll accounts are present. Among them, we find accounts from popular U.S. politicians like Donald Trump

User	Community	Category	Followers	$d_{out}(n_i)$	$d_{out}(n_i)$ weighted
ameliebaldwin	Left	RightTroll	2,464	4,896	9,243
hyddrox	Other	RightTroll	2,225	2,650	6,788
giselleevns	Other	Unknown	24,344	2,282	5,403
patriotblake	Left	RightTroll	2,035	2,856	4,106
mrcldepratt	Right	LeftTroll	914	1,583	3,262
brianaregland	Other	LeftTroll	768	1,360	3,259
baobaeham	Left	LeftTroll	1,032	1,802	3,215
datwisennigga	Other	LeftTroll	904	1,540	3,196
willisbonnerr	Left	LeftTroll	571	1,563	3,155
melanymelanin	Other	LeftTroll	963	1,079	3,071

Table 4: Top 10 users ranked by weighted outdegree

or Hillary Clinton, but also accounts of official media outlets like The Hill or Fox News. The account *thehill* has the highest unweighted indegree with 102, which represents the number of unique trolls who retweeted him in the data. The indegree quickly declines from 102 for rank one to 53 for rank ten. One account that sticks out is *ten_gop*, who is the only troll among the ten highest indegrees. He is categorized a right troll by both Linvill/Warren 2018 and the community detection algorithm. Further investigation shows that *ten_gop* pretended to be an official Republican Party account, which fits his ranking among the other official accounts, even though.

User	Community	Category	$d_{in}(n_i)$	$d_{in}(n_i)$ weighted
thehill	Non-Troll	Non-Troll	102	358
realdonaldtrump	Non-Troll	Non-Troll	100	544
wikileaks	Non-Troll	Non-Troll	82	247
blicqer	Non-Troll	Non-Troll	69	2,207
hillaryclinton	Non-Troll	Non-Troll	61	98
joyannreid	Non-Troll	Non-Troll	58	267
prisonplanet	Non-Troll	Non-Troll	56	462
jamilsmith	Non-Troll	Non-Troll	55	118
ten_gop	Other	RightTroll	53	430
foxnews	Non-Troll	Non-Troll	53	336

Table 5: Top 10 users ranked by indegree

Weighted Indegree does not correlate strongly with the unweighted indegree for the top ten ranked accounts.

User	Community	Category	$d_{in}(n_i)$	$d_{in}(n_i)$ weighted
blicqer	Non-Troll	Non-Troll	69	2,207
conservatexian	Non-Troll	Non-Troll	30	1,082
realdonaldtrump	Non-Troll	Non-Troll	100	544
nine_oh	Non-Troll	Non-Troll	11	500
prisonplanet	Non-Troll	Non-Troll	56	462
zaibatsunews	Non-Troll	Non-Troll	16	451
gerfingerpoken	Non-Troll	Non-Troll	46	434
ten_gop	Other	RightTroll	53	430
bizpacreview	Non-Troll	Non-Troll	17	401
beforeitsnews	Non-Troll	Non-Troll	8	399

Table 6: Top 10 Users ranked by Weighted Indegree

For the k-core we limited the network to the core of $k = 10$, for the k-in-core to $textk-in = 4$, meaning that the users of the k-10-core have been retweeted and/or retweet others at least 10 times and the users of the k-4-in-core have been retweeted at least 4 times, which is the maximum value for k-in in the dataset.⁵ The original graph consists of 36,889 nodes with 147,428 edges, of which the k-10-core contains 1257 (3.4%) nodes and 18214 (12.3%) edges, and the k-4-in-core 1754 (4.8%) nodes and 11988 (8.1%) edges respectively. Although the k-in-4-core contains some nodes more, it has far less edges, which is shown in Figure 4, that depicts both subgraphs. It is immediately apparent, that the k-core still contains the basic structure of the network with its three main clusters, while the k-in-core only consists of one large cluster with mainly right-wing accounts and one very small left-wing cluster. This is contingent with the findings of the degree centrality, which showed that the right-wing trolls have a larger unweighted indegree, while the results are more equal for the unweighted degree. This is no surprise considering the k-in-core is calculated through the indegree. Interestingly, the k-10-core looks very different.⁶ Here, the basic structure of the entire network is still intact, which indicates a lot of left and hashtagger accounts retweeting right-wing IRA accounts in the k-10-core. In other words, IRA accounts retweet other trolls mainly from the left and hashtagger clusters, while right-wing accounts mainly retweet themselves.

Since the k-in-core consists mostly of right-wing accounts, a further analysis of the k-

⁵We disregarded self loops, since they cannot count as new information and are therefore irrelevant for analyzing information spreading.

⁶A quick analysis in Gephi via filtering gives the same results for the k-18-core, when only 271 nodes are left.

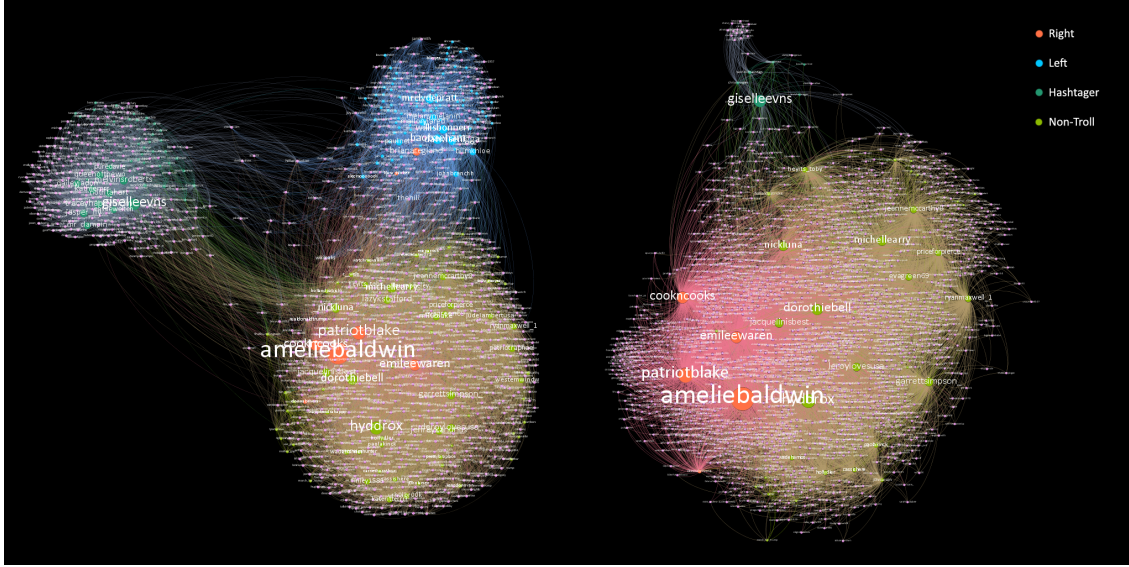


Figure 4: k-10-core and k-in-4-core. Node and label size represent degree centrality, colors reflect community.

10-core seems to be more fruitful. The accounts in the k-10-core are those with the best positions in the network regarding the ability to spread information. We therefore proceed to examine the most active accounts, since they can be considered as the most influential. Figure 5 provides an overview of the 30 accounts with the highest outdegree within the k-10-core, and thus the profiles who retweeted the relevant accounts most often. The profile *ameliebaldwin* has by far the largest outdegree, which puts this account at the central position of the core. Interestingly, of the top 6 profiles, 4 were categorized as *Other* by the community detection algorithm. Looking on Figure 4, they all are very close to the right-wing community (the same is true for the k-in-core). Linvill and Warren categorized most of them as right-wing as well, which indicates some inaccuracy of the community detection algorithm, i.e. it is too sharp, thus detecting too many communities. Seeing them as right-wing shows a very clear dominance of right-wing profiles concerning information super-spreaders, which is consistent with our previous findings.

4.2 Discussion

5 Conclusion

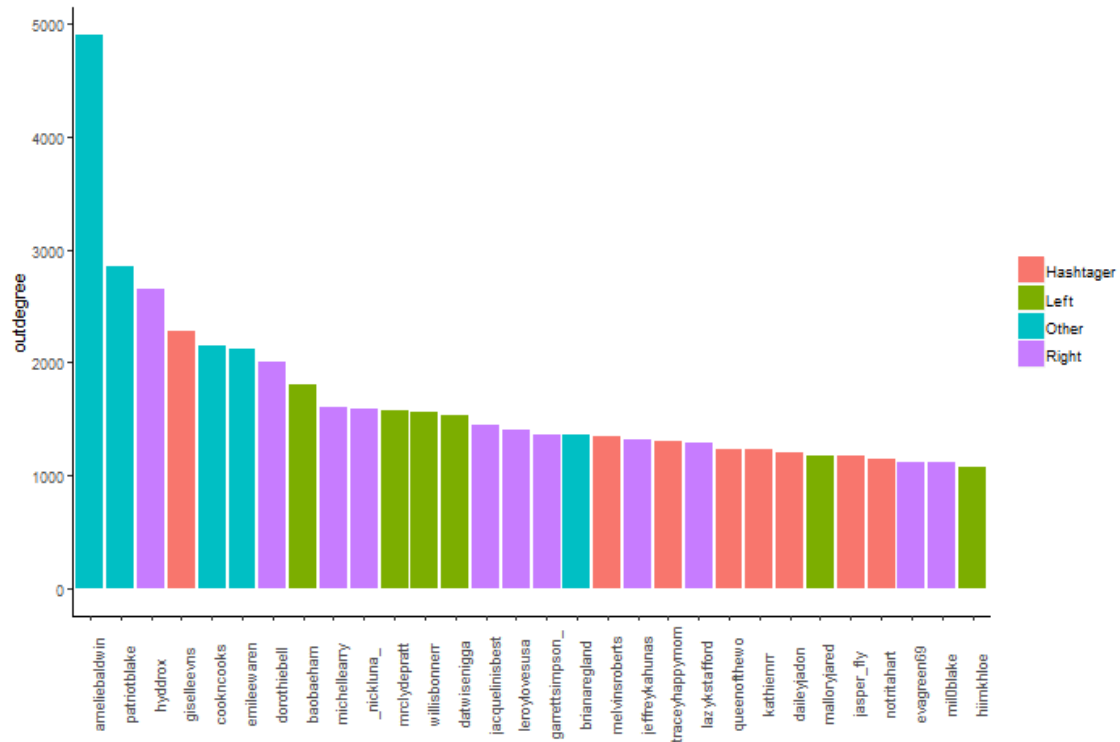


Figure 5: Top 30 user regarding outdegree in the k-10-core.

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