

TWITTER AND SOCIETY



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TWITTER AND SOCIETY

EDITED BY KATRIN WELLER, AXEL BRUNS,
JEAN BURGESS, MERJA MAHRT, & CORNELIUS PUSCHMANN



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Metrics for Understanding Communication on Twitter

6

CHAPTER Axel Bruns and Stefan Stieglitz



.@sender, @receiver, timestamp,
http://url.org/, #hashtags—a tweet consists
of much more than just 140 characters

As the systematic investigation of Twitter as a communications platform continues, the question of developing reliable comparative metrics for the evaluation of public, communicative phenomena on Twitter becomes paramount. What is necessary here is the establishment of an accepted standard for the quantitative description of user activities on Twitter. This needs to be flexible enough in order to be applied to a wide range of communicative situations, such as the evaluation of individual users' and groups of users' Twitter communication strategies, the examination of communicative patterns within hashtags and other identifiable *ad hoc* publics on Twitter (Bruns & Burgess, 2011), and even the analysis of very large datasets of everyday interactions on the platform. By providing a framework for quantitative analysis on Twitter communication, researchers in different areas (e.g., communication studies, sociology, information systems) are enabled to adapt methodological approaches and to conduct analyses on their own. Besides general findings about communication structure

on Twitter, large amounts of data might be used to better understand issues or events retrospectively, detect issues or events in an early stage, or even to predict certain real-world developments (e.g., election results; cf. Tumasjan, Sprenger, Sandner, & Welp, 2010, for an early attempt to do so).

In principle, the exploration of such universal metrics for the analysis of Twitter communication is straightforward, and builds immediately on the communications data and metadata which is available through the Twitter Application Programming Interface (API; see Gaffney & Puschmann, Chapter 5 in this volume). Given the range of metadata which is associated with each tweet retrieved through the API, and the additional data points which may be extracted from the tweet text itself, a series of key metrics emerge; we outline these in the first part of this chapter. However, the effective use of such metrics also depends on a deeper understanding of the communicative phenomena which they describe; as with any quantitative approach, a focus merely on the raw figures themselves is likely to obscure more important patterns within the data. These can only be uncovered by the careful consideration of the provenance of the overall data set, as well as through the sensible selection of specific subsets of the overall dataset for further analysis. We point to such considerations by providing a discussion across specific data sets of Twitter communication in the second part of the chapter. Finally, we provide a short overview about how the metrics we identified can be beneficially combined with other well-established methods.

The concepts we introduce here provide a fundamental set of analytical tools for the study of public communication on Twitter, but they do not purport to represent an exhaustive list of possible metrics for the description of Twitter-based user activities. Additional, more specific metrics which relate to particular communicative contexts on Twitter may also be developed; we encourage researchers to document their analytical choices in such specific cases in similar detail, so that these metrics can also become part of the wider toolkit of conceptual models and practical methods which is available to social media researchers.

BASIC METRICS

Centrally, the Twitter API provides the tweet text itself, the username and numerical ID of the sender, and a timestamp which is accurate to the second; further metadata (which are likely to be of use only in more specific cases) include fields providing the—at present, rarely used—geolocation of the sender

at the time of tweeting, the client used to send the tweet (e.g., Web, *Tweetdeck*, Blackberry), and a reference to the user's Twitter profile picture. Additionally, structural analysis of the tweet text itself will be able to reveal whether the tweet contains one or multiple hashtags, one or multiple @mentions of other users, and/or references to any URLs outside of Twitter. Finally, it may also be possible to identify whether @mentions of other users represent (manual) retweets in one of a number of the widely used syntactical formats (e.g., RT @user, MT @user, via @user, or "@user") which indicate retweets. Outside of retweets, a distinction between mere @mentions—that is, references to another user which are not inherently intended to strike up a conversation—and intentional @replies is likely to be much more difficult to establish, not least also because the transition between both is gradual: the first @mention in what eventually becomes a multi-turn @reply chain is always both @mention *and* @reply.

For each message, then, the following key data points can be established by analysing the tweet itself and its associated metadata:

- sender: Twitter username and numerical ID
- recipient(s): @mentioned usernames in the tweet (if any)
- timestamp: accurate to the second
- tweet type: retweet, genuine @reply (non-retweet), or original tweet (no @mentions)
- hashtag(s): hashtags referenced in the tweet (if any)
- URLs: URLs included in the tweet (if any)

As noted above, further metrics may also be developed—for example by examining whether the tweet contains mentions of specific keywords or named entities which are of interest in the particular research context, or whether the tweet is composed in a specific language and/or character set. As these metrics are case-specific, however, they are unlikely to be generalisable for comparative Twitter research beyond such individual cases, and do not concern us here.

Automated parsing of all tweets within a given dataset (see Bruns, 2012, for an implementation in the pattern-matching language Awk), then, is able to determine these data points on a tweet-by-tweet basis. This information may then be aggregated into a detailed set of metrics which describe the communicative patterns captured in the dataset; such aggregation can be performed, *inter alia*, for each specific timeframe within the dataset (minutes, hours, days, . . .); for each individual user participating (as active sender of tweets, or as recipient of @mentions) in the dataset; and for larger groups of users which have been identified on the basis of specific criteria. A further combination of

these approaches (to develop diachronic metrics for specific users, for instance) is also possible, of course. (Several of the chapters in the “Practices” section of Part II of this volume pursue such approaches.)

TEMPORAL METRICS

Metrics which describe the communicative patterns captured in a given Twitter dataset over time are a crucial tool for the identification of important phenomena for further—not least also qualitative (cf. Einspänner, Dang-Anh, & Thimm, Chapter 8 in this volume)—investigation. At their simplest, such metrics may simply outline the overall volume of tweets within a dataset (which may comprise messages containing a given hashtag or keyword, for example) statically or dynamically (e.g., to show particular spikes or lulls in user activity; see, for example, Stieglitz & Krüger, 2011). Following the syntactical parsing of tweets, however, it also becomes possible to track such volumes separately for original tweets, @replies, and retweets, or for tweets containing URLs or hashtags; this can trace, for example, the dissemination of key information (URLs) or the emergence of new concepts and memes (hashtags) on Twitter.

Additionally, it may also be important to examine the number of unique users participating in the communicative process at any one time, and compare this with the volume of tweets; this may help to distinguish moments of especially heated discussion (marked by an increase in tweets per user) from spikes in activity that are caused by an influx of active users (marked by an increase in tweet volume, but not in tweets per user). Similarly, researchers may wish to track the activities of specific users or groups of users over time, to examine how these users respond (differently) to particularly communicative events, and even to explore the types of tweets such users send at different points in time; we return to these questions below.

USER METRICS

Such user-based metrics may also be calculated independently of the temporal dimension, of course. In this case, what emerges is a more comprehensive picture of the respective communicative strategies employed by different users on Twitter: most importantly, this approach can determine the overall balance between original tweets, @replies, and retweets for each user, and thereby draw distinctions between users who take a largely annunciative approach

(mainly original tweets), conversational approach (mainly @replies), or disseminative approach (mainly retweets). Various combinations between such approaches—potentially shifting over time—are also possible. Further, the extent to which users include URLs in their tweets may also be included in this analysis. In addition to examining user activity, similar metrics are also available for the recipients of @mentions within the dataset. Here, it is possible to examine the balance between @replies and retweets received by each user referenced in tweets contained in the dataset. Such metrics can be understood, in the first place, to provide an evaluation of the visibility and importance of each user to those of their peers who actively sent tweets in the dataset, and a further distinction between @replies and retweets may also point to whether these recipients are mainly positioned as partners in conversation (@replies received) or sources of information (retweets received; also cf. Weller, Dröge, & Puschmann, 2011, on this point). Indeed, a further comparison between the metrics for incoming and outgoing tweets for each user provides additional detail on their specific placement within the communicative context contained in the dataset. Users who receive many @mentions, but rarely @reply in return, must be seen mainly as subjects of conversation; users who both receive and send @replies frequently, by contrast, are active subjects *within* conversation. Similarly, users who receive substantial retweets without having sent a substantial number of tweets themselves may be seen as having provided more important impulses to the dataset than users who tweet frequently, but receive a relatively low number of retweets from others.

GROUP METRICS

While such per-user metrics are useful for an identification of the most active and most visible users within a dataset, and for a detailed evaluation of their specific types of communicative activity on Twitter, it will often also be useful to aggregate these metrics both for known, pre-existing groups of Twitter accounts (as determined by the specific research agenda), or for groups of users which emerge from the quantitative analysis of the dataset itself. As the first of these possibilities is necessarily case-specific, we discuss only the second here, focussing on a grouping of users by their level of contribution to the dataset itself. From the per-user metrics, the total number of tweets sent by each contributor to the dataset is already known; on this basis, users can be ranked and distinguished into a number of specific, more and less active groups. While such distinctions may in principle be made along any line, user activity in most communicative situations on Twitter and other platforms will be distributed in keeping with a

power law: a comparatively small number of highly active users are likely to dominate the dataset, while a much larger “long tail” (Anderson, 2006) of far less active users will be responsible for a smaller volume of tweets. Therefore, a distinction of users using the 10/90 or 1/9/90 rule (Tedjamulia, Dean, Olsen, & Albrecht, 2005) is sensible here: a 1/9/90 division, for example, groups the one per cent of lead users (as measured by the number of tweets they contributed to the dataset) separately from the next nine per cent of still highly active users, and separately in turn from the remaining 90% of least active users in the long tail of participants. Using such distinctions, it is then again possible to determine the tweeting patterns for these three groups: the number of original tweets, @replies, and retweets they have sent, as well as the number of tweets containing URLs (or other, specific communicative markers as relevant to the research project). Additionally, it may also be important to examine the number of users from each of the three groups (as defined over the *entirety* of the dataset) who are active during any individual temporal period covered by the dataset: this indicates, for example, whether established lead users were highly active throughout the time frame under examination, or whether there were times when normally less active users gained a greater share of the overall discussion.

INTERPRETING TWITTER METRICS

Such standard metrics represent a powerful tool for the analysis of communicative activities and interactions on Twitter; however, they must also be employed correctly in order to generate a reliable (and ultimately, comparable) picture of communicative processes on Twitter. Here, it becomes crucial to consider the provenance of the dataset under examination, in order to determine the limits of what forms of communicative activity it may or may not contain. Most commonly, at present, the metrics which we have described here are extracted from Twitter datasets which have been raised on the basis of keyword or hashtag filters. This means that they necessarily contain only a selection of all communication taking place on Twitter, and indeed, even represent only a subset of all communicative activity which may be relevant to the themes described by the keywords or hashtags themselves. Hashtags, for example, are used to explicitly mark tweets as relevant to a specific theme, but this also means that hashtag datasets do not contain *all* relevant tweets, but only those whose authors knew of and felt motivated enough to include the hashtag in the tweet. Furthermore, hashtags may be misused (accidentally or on purpose, e.g. by spammers; cf. Mowbray, Chapter 14 in this volume). In this case, some tweets

will be included in the dataset which are not actually related to the intended topic. Most importantly, what is missing from such datasets are the messages which engage in follow-up conversation to a hashtagged tweet, but were not deemed important enough by their authors to receive a hashtag themselves. When our standard metrics are applied to such hashtag datasets, therefore, it is likely that the metrics which describe communicative interaction through @replying—though correct for the hashtag dataset itself—may significantly underestimate the full volume of @replies which was prompted by hashtagged tweets. Conversely, since hashtags most centrally represent a convention designed to make tweets more easily discoverable, it is also likely that metrics for hashtag datasets overestimate the extent to which retweeting of messages relating to the hashtag topic takes place on Twitter: hashtagged tweets may be retweeted disproportionately much, by the very virtue of *being* hashtagged.

For keyword datasets, on the other hand, the situation is different again. While hashtags can (but not always do) serve as a means to enable the coming-together of *ad hoc* publics which interact with one another, the same is not usually true of mere keywords; a keyword dataset, therefore, constitutes a cross-section through the Twitter activities of users who are largely unlikely to be aware of one another, while hashtags inherently provide at least the potential for such awareness. Although hashtag datasets themselves already miss much of the @replying which may take place *around* the hashtag (but without using it in tweets), keyword datasets may well be likely to further underestimate @replying activity, as they will contain @replies only if they contain the selected keyword, but will rarely pick up full threads of communication. Keyword datasets necessarily contain fragments of wider conversation, therefore, and their metrics must be understood from that perspective. Such critiques are not meant to fundamentally dismiss the value and validity of research which utilises such datasets; rather, they seek to highlight the advantages and disadvantages of specific sampling approaches for Twitter data in the context of the metrics which may be established for such datasets.

As long as hashtag or keyword datasets remain an important tool for Twitter research, at any rate (and there is no reason why they should not), what is important is simply to recognise these inherent distortions in observable communication patterns which are caused by the approaches chosen to observe them, and to ensure that in broader, comparative investigations across individual cases, like is compared with like. Where these limitations are understood, then, the standardised metrics which we have outlined here can generate important

new insight into the divergence or systematicity of communicative patterns on Twitter, as we demonstrate in the following.

METRICS COMPARISONS ACROSS SPECIFIC CASES

The metrics we have outlined here are valuable for an examination of individual communicative phenomena as described by specific datasets; however, by providing a standard approach to quantifying communicative activity on Twitter, they also especially lend themselves to cross-comparisons. Such comparisons are able to uncover significant differences in how the same communicative affordances (Twitter itself, as well as specific mechanisms such as hashtags, @replies, or retweets) are used in different contexts and by different groups of users, hinting at a range of more fundamental patterns which may well reflect deep-seated principles in human communication well beyond the Twitter platform itself. We illustrate this through two comparative analyses. Figure 6.1 shows the relative contributions of more and less active user groups (determined according to the 1/9/90 rule outlined above) to a range of hashtag datasets:

- #auspol: Australian political discussion, 8 February to 8 Dec. 2011.
- #occupy: political discussion about the Occupy movement, 19 Dec. 2011 to 19 Apr. 2012.
- #masterchef: backchannel for a popular Australian television show, 1 May to 8 Aug. 2011.
- #royalwedding: backchannel for the wedding of Prince William and Catherine Middleton, 29 Apr. 2011.
- #stopkony: viral campaign to arrest Ugandan warlord, Joseph Kony, 8 to 21 Mar. 2012.

Our analysis of the relative contributions made by the three groups of users in each case reveals some stark differences between these cases. The #auspol hashtag, containing some 850,000 tweets during the period analysed, is clearly dominated by a small group of some 260 lead users, who posted well over 60% of all tweets; indeed, in combination, the two most active groups of users, representing ten per cent of the total number of unique users participating in the hashtag, posted more than 90% of all tweets captured in the dataset. #occupy and #masterchef display similar patterns: in each case, these two groups are responsible for more than 60% of all tweets. This can be seen as evidence of a well-established elite of Twitter users which dominates these hashtags, and

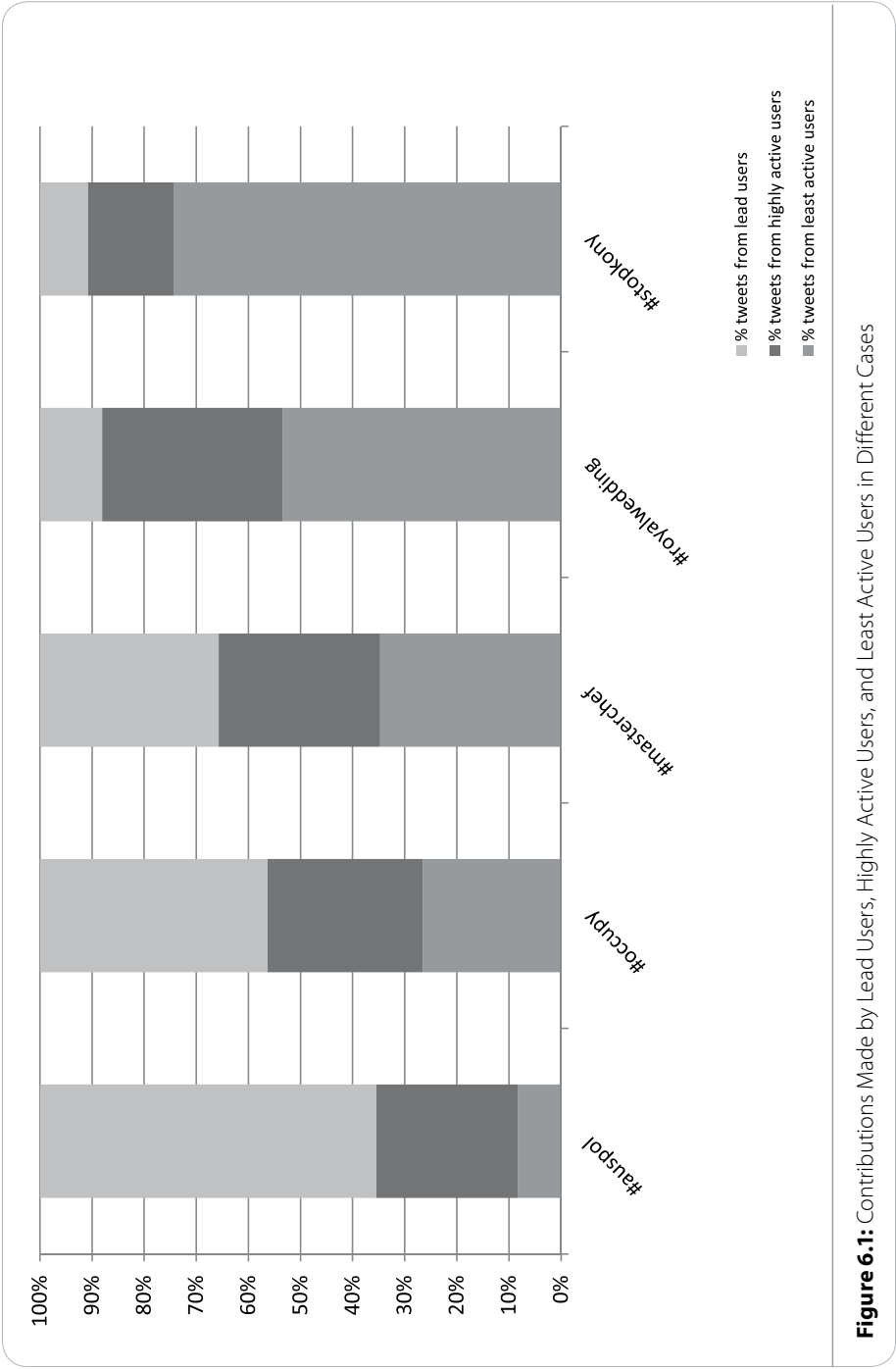


Figure 6.1: Contributions Made by Lead Users, Highly Active Users, and Least Active Users in Different Cases

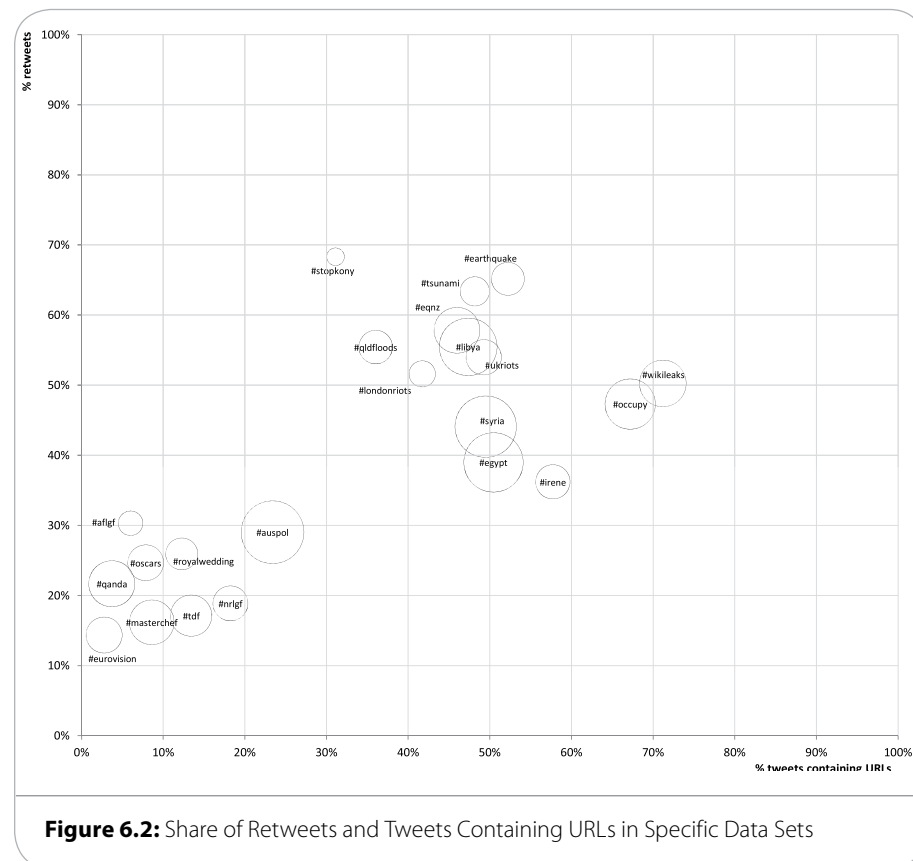
may point to the presence of genuine community structures, centred around the leading users.

Hashtags such as #stopkony and #royalwedding show a considerably less pronounced domination by leading users; here, the most active one per cent of users accounts for just over ten per cent of all tweets, and the least active 90% of the user base comes much closer to contributing to the hashtag to an extent that reflects their numerical advantage. For #stopkony, this underlines the viral nature of this campaign: although made visible by the public endorsements from a handful of Twitter celebrities which were deliberately targeted by the Kony 2012 campaign (cf. Paßmann, Boeschoten, & Schäfer, Chapter 25 in this volume), the campaign itself (and its associated hashtags) gained and maintained momentum because many of the millions of followers of these celebrities in turn retweeted their #stopkony tweets. The bulk of hashtag activity, therefore, results from individual users whose involvement may remain marginal (at its most basic, in the form of single retweets); only a few users participated in more comprehensive ways.

The #royalwedding hashtag, finally, represents a far more time-limited event, unfolding on a single day. Here, although there is substantial activity in the hashtag itself (with over 920,000 tweets from close to half a million unique users), there may not have been enough time for community structures and a recognised group of leading users to emerge; it is the intermediate group of highly active (but not leading) users which is especially prominent in this case, therefore. Given the necessarily singular nature of the event, we can only speculate that, had the hashtag continued for a longer period of time, the balance between lead and highly active users may gradually have shifted, finally resulting in a more dominant group of lead users, recruited from this pool of already highly active participants.

If such comparisons of the relative structures of different hashtag user communities (to the extent that they indeed act *as* communities) can reveal important differences in how hashtag publics operate, further comparison of actual communicative patterns within hashtags is also valuable. Figure 6.2 presents a comparison of two key metrics for a wide selection of hashtags (also cf. Bruns & Stieglitz, 2012, for a more wide-ranging comparison): for each hashtag, it plots the percentage of tweets containing URLs against the percentage of tweets which are retweets. Two broad clusters of hashtags are immediately obvious. One set of hashtags is marked by a low percentage both of URLs and of retweets; these hashtags represent foreseen, well-publicised, television events, and include (in addition to #royalwedding and #masterchef) popular shows such as the Eurovision and

Oscars awards, the Australian Football League and Australian National Rugby League grand finals, the Tour de France, and the Australian political talk show *Q&A*. In such cases, Twitter serves as a backchannel to television, and enables its users to participate in a mediated, communal form of audiencing (Fiske, 1992) which—because of the shared television text upon which it is based—requires neither the exchange of additional information in the form of URLs nor substantial retweeting of messages to raise awareness of an issue or topic. The long-term discussion of Australian politics in #auspol behaves in a similar fashion; we might speculate that #auspol participants are similarly engaging in a form of audiencing, if in reaction to the overall media coverage of political matters rather than in relation to one unified audiovisual text. They are, in essence, *fans* of politics who use Twitter as a backchannel for the play-by-play discussion of plot developments in the Australian political narrative.



The second cluster, whose hashtags contain substantial percentages of both URLs and retweets, comprises events such as the popular revolts in Libya, Egypt, and Syria in the course of the 2011–2012 Arab Spring; natural disasters such as the earthquake and tsunami on the Sendai coast in Japan, the 2010–2011 earthquakes in Christchurch, New Zealand, the 2011 floods in Queensland, Australia, and the 2011 Hurricane Irene which affected the US; and the riots in London and the wider UK. Hashtags such as #stopkony, #occupy, and #wikileaks are also associated with the cluster, though showing some divergence from common communicative patterns.

For hashtags within this cluster, finding and sharing information by posting and retweeting tweets which contain URLs is a core practice; this is in keeping with a process of collaborative curation of information on the hashtag topic through gatewatching (Bruns, 2005). Such activities are commensurate with breaking news: at times when there is an information deficit about the exact situation on the ground, Twitter users seem to come together to pool resources, and thereby curate what information is coming to hand. This may also explain the differences between individual hashtags within the cluster itself: as later and comparatively well-reported stages of the Arab Spring, the uprisings in Egypt and Syria were able to tap into already relatively well-established networks of Twitter users, requiring comparatively less retweeting to disseminate information; similarly, as an anticipated weather event, tweets about Hurricane Irene did not need to be retweeted widely in order to become widely visible. By contrast, the earthquakes as well as the Queensland floods or UK riots could not be foreseen, and therefore represent potentially more shocking breaking news events; widespread retweeting to raise awareness is to be expected in such situations.

A viral campaign such as Kony 2012 is comparable to such crisis events; indeed, the very principle of such viral campaigning is to achieve widespread visibility within a very short space of time, and thereby to generate further follow-on media coverage. The Kony 2012 campaign effectively managed to instil this sense of crisis in its supporters. By contrast, however, movements such as Occupy and platforms such as WikiLeaks are responses to a sense of ‘permanent crisis’ in conventional democratic systems; additionally, they are marked by a deep distrust of the mainstream media’s ability to provide balanced information. Therefore, the extensive presence of URLs in #occupy and #wikileaks tweets is unsurprising.

This necessarily brief discussion points to an underlying systematicity in how Twitter users utilise the platform to communicate. The patterns which we have outlined here are by no means exhaustive, of course; other common

uses of Twitter may be uncovered by examining a wider range of hashtag datasets, by exploring communicative patterns in Twitter datasets which are based on principles of selection other than the presence of hashtags in tweets, or by exploring the correlations between other elements of the standard metrics we have outlined above. What even these brief examples highlight, however, is the inherent value of such systematic approaches to generating standardised metrics for the description of communicative processes on Twitter.

CONCLUSION: COMBINING METRICS AND METHODS

As we have demonstrated, the investigation of communicative metrics on Twitter provides relevant findings to better understand the overall patterns within this communication. Combining these different metrics with other well-established methods such as manual content analysis, sentiment analysis, or social network analysis allows researchers to derive further, in-depth results. Of course, the appropriateness of such combinations depends strongly on the specific research question. For instance, sentiment analysis combined with temporal metrics might deliver more information about changes in sentiment among Twitter users in a specific time frame and in relation to certain issues (see, for example, Papacharissi & de Fatima Oliveira, 2012). Manual content analysis combined with user metrics, by contrast, might enable a detailed analysis of the communicative efforts of specific actors.

Obviously, there are several more ways to combine the metrics outlined in this chapter with well-established methodologies. However, to date, such mixed-method approaches are used only very rarely (e.g., Stieglitz & Dang-Xuan, 2012). Researchers in this field must continue to work on identifying and documenting metrics, as well as on developing more comprehensive frameworks to combine metrics and methods.

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