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Social Media Analytics: Analysis and Visualisation of News Diffusion using NodeXL

Abstract

Purpose: The purpose of this paper is to provide an overview of NodeXL in the context of news diffusion. Journalists often include a social media dimension in their stories but lack the tools to get digital photos of the virtual crowds about which they write. NodeXL is an easy to use tool for collecting, analysing, visualizing, and reporting on the patterns found in collections of connections in streams of social media. With a network map patterns emerge that highlight key people, groups, divisions and bridges, themes and related resources.

Design/methodology/approach: This study conducts a literature review of previous empirical work which has utilised NodeXL and highlights the potential of NodeXL to provide network insights of virtual crowds during emerging news events. It then develops a number of guidelines which can be utlised by news media teams to measure and map information diffusion during emerging news events.

Findings: One emergent software application known as NodeXL has allowed journalists to take 'group photos' of the connections among a group of users on social media. It was found that a diverse range of disciplines utilise NodeXL in academic research. Furthermore based on the features of NodeXL a number of guidelines were developed which provide insight into how to measure and map emerging news events on Twitter.

Social implications: With a set of social media network images a journalist can cover a set of social media content streams and quickly grasp "situational awareness" of the shape of the crowd. Since social media popular support is often cited but not documented, NodeXL social media network maps can help journalists quickly document the social landscape utilising an innovative approach.

Originality/value: This is the first empirical study to review literature on NodeXL, and to provide insight into the value of network visualisations and analytics for the news media domain. Moreover, it is the first empirical study to develop guidelines that will act as a valuable resource for newsrooms looking to acquire insight into emerging news events from the stream of social media posts. In the era of fake news and automated accounts i.e., bots the ability to highlight opinion leaders and ascertain their allegiances will be of importance in today's news climate.

Keywords: Social Media, Social Network Analysis, Twitter, Information Diffusion

Paper type Research Paper

Introduction

Social media platforms generate substantial amounts of information on a range of topics and have become important channels of information flow in the 21st century (Weller et al., 2014). Originally, social media were created to allow members of the public to connect to one another for personal use but their use now stretches beyond this. One area that has benefited from the advent of social media are newsrooms because journalists are likely to include a social media element to their stories. Indeed, citizens may now also expect media sources to provide a social media element. One social media platform that has risen in popularity for its ability to diffuse news rapidly across the world is Twitter.

Twitter boasts an impressive three hundred and twenty eight million monthly active users with one billion unique visits to tweets across the World Wide Web (About Twitter, n.d), and Twitter is utilised by a subset of the global human population (Ahmed, 2017; Andrew Perrin, 2015; Holmberg and Thelwall, 2014). Due to the number of active users of Twitter emerging news events may appear to be reported on Twitter prior to reaching traditional media outlets. It is not surprising, therefore, that tweets in themselves have become to appear on television and television news (Lefky et al., 2015) and also within newspapers as direct sources of information in themselves (Brands et al., 2018).

However, it can be argued that Twitter has been poorly mapped and understood for its network properties by news media. This is because although it is possible to visualise the structure of a conversation on Twitter and to identify prominent users and the overall structure of the conversation in order to garner the situational awareness of an emerging news story this aspect of Twitter is seldom reported on by news media. One software application which has gained in popularity for mapping and measuring content from social media platforms is known as NodeXL. NodeXL is a free, open source template for Microsoft Excel

versions 2007, 2010, 2013, and 2016 which allows users to generate social network graphs. NodeXL Pro, a subscription, service, offers a number of additional features such as advanced network data streams, advanced network metrics, text and sentiment analysis, as well as powerful report generating. By making use of NodeXL it is possible to understand how communities form online, and to identify influential users as well as to pinpoint the content they share. NodeXL requires no specific technical knowledge and can be utilised by researchers from the social sciences.

NodeXL has been recently used to map and measure social media content during natural disasters in order to identify user interaction of communities (Daga, 2017). By doing so, insight can be gained into the interaction of Twitter users in an online community and can play a vital role in disseminating information during disaster and emergency situations. Similarly, news organisations can benefit by mapping online communities in order to gain insight into key information diffusers, popular sentiment, and overall discussion. Previous research, for instance, has used NodeXL to map and measure the information diffusion of content surrounding emerging news stories such as the Occupy Wall Street movement (Park et al., 2015).

The overall aim of this paper is to provide an overview of NodeXL and its potential for analysing and visualising news on Twitter. The objectives of the paper are to review the current uses of NodeXL in academic work including those from outside the area of social media, and then to specifically highlight the unique features of NodeXL for analysis and visualisation of news diffusion. The paper then proposes guidelines for newsrooms and journalist to grasp the situational awareness of emerging news events utilising NodeXL.

Literature Review

The section will explore trends in this area which centre on the rise of news consumption through social media, challenges around data access, social media manipulation and the importance of having appropriate tools to analyse streams of social media data.

It can be argued that the importance of gaining insight into social media has been well established as early research has highlighted the global use of social media platforms and the potential to study inter-personal communication (Boyd and Ellison, 2007; Kaplan and Haenlein, 2010; Thelwall, 2009). In recent years the influence of social media on society has been well studied (Fuchs, 2017) and in order to enable and encourage this form of research there have been calls for better tools for studying social media data (Ahmed, 2015). Scholars have noted the potential of such tools in the domain of social science research (Felt, 2016).

One issue that faces studying social media is that not all social media platforms make their data available to access for research purposes. Nine out of the top ten most used platforms significantly restrict data access (Ahmed, 2017) consequently making it a challenge to study them. There may be possibilities join 'in-house' research teams at social media companies such as Facebook, but this is likely to be limited to a handful of researchers and can be an extremely competitive process.

One of the few social media platforms to provide near-complete public access to its data is Twitter and it can be argued that the infrastructure of Twitter is unique (Ahmed, 2018a) such that the majority of Twitter accounts are public (Marwick and boyd, 2011). Furthermore, due to the ability to make use of hashtags on the platform that anyone can contribute to makes Twitter an ideal platform for emerging news stories. The 'trending' feature on Twitter will display users topics attracting the most tweets regionally or nationally depending on the

setting selected by a Twitter user (Kwak et al., 2010) . Newsrooms, therefore, are in a unique position to be able to rapidly analyse Twitter data during emerging events.

A recent trend to have emerged is the increased consumption of news through social media with 67% of Americans indicating that they consume some form of news from social media (Shearer and Gottfried, 2017). One well-known case of news emerging through Twitter before traditional media outlets was the death of Osama Bin Laden which was leaked on the platform (Hu et al., 2012). Moreover, Hu et al (2012) noted that one of the reasons for Twitter users to become convinced of this was because the users who were posting the news appeared to be journalists and politicians i.e., reputable individuals. Scholars have noted that users of social media platforms are likely to be influenced by opinion leaders whom play a critical role in how news is disseminated on social media (Bergström and Belfrage, 2018).

Twitter also has potential for citizen journalism because most smartphones are now able to capture an image on their device and have it uploaded to Twitter in under 45 seconds (Murthy, 2011). An iconic example of this is a passenger on the Midtown Ferry whom photographed a downed U.S Airways jet floating in the Hudson river in 2009 prior to the mainstream media even arriving to the scene (Murthy, 2011). These cases highlight the power of Twitter in the rapid cascading and diffusing information during emerging news events. Recent research has also found that untruthful information on social media has the potential to spread faster than truthful information (Vosoughi et al., 2018).

Scholars have also found evidence of social media for 'agenda setting' i.e., the ability to influence the news agenda of traditional media coverage (Feezell, 2018; Gidengil, 2014). This could potentially serve as a useful function as it may allow activists to raise awareness for legitimate causes. However, an area of concern in recent years is that social media

manipulation is on the rise and it has been suggested that for certain topics related to Russia tweets which are produced by automated accounts could exceed 50% (Stukal et al., 2017). A recent study also found that Russian trolls on Twitter may promote discord around vaccines and share anti-vaccine content (Broniatowski et al., 2018). A recent report by the Oxford Internet Institute (OII) from Oxford University has noted that computational propaganda is growing at a large rate (Bradshaw and Howard, 2018). The report noted that at least 48 countries have experienced some form of social media manipulation with half a billion dollars spent by political parties in areas such as psychological operations with the goal of manipulating public opinion (Bradshaw and Howard, 2018).

Therefore, with the rise of social media coupled with the occurrence of social media manipulation the ability to identify information diffusers and opinion leaders is ever more important for news organisations. However, to be able to critically study this content journalists will need access to tools that can analyse social media data. This paper will review literature around an emerging and exciting tool NodeXL which can pinpoint opinion leaders, and analyse overall content such as key topics, hashtags, websites and so forth. The paper will then outline how NodeXL can be applied by newsrooms by developing guidelines for its use.

Methods

In this study we utilised the Primo Central search engine at the University of Sheffield in order to locate literature, which includes over 17 journal databases including Scopus, MEDLINE, Springer Link, arXiv, and Web of Science. In addition to using keyword search, citation analysis of identified literature was also utilised (i.e. looking up references in bibliographies). Search terms were also entered into Google and Google Scholar. The date

parameters for locating literature were from 2007 to 2018. The search terms utilised to locate literature on NodeXL's use in relation to social media consisted of 'NodeXL', 'NodeXL AND Twitter', 'NodeXL AND Facebook', 'NodeXL AND LinkedIn', and 'NodeXL AND Instagram'.

Terms that are more specific were used to identify potential different disciplines that may have used NodeXL and these terms consisted of 'NodeXL AND Health', 'NodeXL AND Politics', 'NodeXL AND News', 'NodeXL AND Disasters', 'NodeXL AND Natural Disasters', and 'NodeXL AND Scholarly Communication'. Our inclusion criteria for studies were that:

- The study would use NodeXL to analyse data.
- The study was written in English.
- The paper could be accessed online.
- The study was published in a journal and/or conference paper.

Furthermore to the aforementioned strategy above, two authors downloaded and reviewed 100 papers from the most popular citation from Google Scholar (Smith et al., 2010) based on the inclusion criteria above. In total, 24 papers met the criteria and the topics that they analysed were extracted.

Results

By conducting a literature review it was found that there is a wide range of disciplines that have utilised NodeXL for the analysis of research data. NodeXL was most recently mentioned in an article published in The Lancet, a flagship medical journal, for its ability to analyse social media data related to infectious disease outbreaks (Mackenzie, 2018). The article noted that NodeXL reports were able to display popular content and provide insight into popular webpages that were cited in tweets. The use of NodeXL was also recently highlighted in a study which identified polarised crowds and opinion leaders in topics

related to a viral hashtag on Twitter around abortion titled '#ShoutYourAbortion (Ahmed, 2018). NodeXL in academic work has also ranged from the analysis of blackboard discussion boards (Waters and Gasson, 2012), blogs (Saffer, 2013), personal email networks (Bengfort and Xirogiannopoulos, 2015), internal security (Gamachchi et al., 2017), medical data analysis (Piepoli et al., 2012), political sponsorship (Piepoli et al., 2012), news stories (Quinn and M. Powers, 2016), campus based social media platforms (Tang et al., 2011), and Wikipedia (Ferron and Massa, 2011).

The majority of studies which have cited NodeXL would use the program for the analysis of Twitter data, and these would form around a diverse range of fields and topics. A study (Tremayne and Minooie, 2013) utilised Twitter data using NodeXL in order to study opinion leadership around gun control shorty after gun-related violence in the United States. Others have studied political movements such as the Occupy Wall Street movement (Tremayne, 2014), health topics such as childhood obesity (Harris et al., 2014b), UK local authorities (Panagiotopoulos and Sams, 2012), natural disasters, health (Harris et al., 2014a), information diffusion (Russell et al., 2015), trust on social networks (Faisal et al., 2014), libraries (Ewbank, 2015), and political language use (Piepoli et al., 2012) have also all been studied.

An aspect important to social media for news diffusion is its ability to map the situational awareness of protest movements that typically receive a burst of social media attention. This is because key protesters will play a significant role during a protest by diffusing information and disseminating specific types of information. For example, a study (Zamir, 2014) would use NodeXL in order to map discussion around the 2013 Shahbag movement in Bangladesh which refers to a series of protests following demands for the capital punishment of a number of individuals convicted of war crimes. Using NodeXL, it is possible to capture virtual crowds that may gather on social media platforms on Twitter via the use of network and

graph theories. By doing so, the study found that those users who were influential during this time period consisted of citizens and journalists.

A further study would use NodeXL to evaluate information cascades that would take place in online discussion related to the #RaceTogether campaign (Feng, 2016) . In using NodeXL it was possible to identify five different types of influential users such as those starting conversations, those influencing discussion, active engagers, network builders, and users who were acting as a bridge for information. NodeXL is particularly apt for studying hashtags and a further recent study utilised NodeXL to study abortion content and found that Twitter discussion would form in two polarised groups such as users whom are either pro-abortion and those that are anti-abortion with low interaction between the groups (Ahmed, 2018)

NodeXL has also been applied in helping libraries promote their services, for instance, one study would use NodeXL to identify influential accounts connected to the libraries and would then strategically create and disseminate content for maximum exposure (Shulman et al., 2015). The study by Shulman et al (2015) also highlights how NodeXL could be utilised by news media organisations and journalists for identifying influential accounts and finding ways to share content with them which could potentially increase the reach of news articles.

General elections are likely to be of interest to news organisations as they are often reported on; and in one study NodeXL was utilised to study network structures during the German National Election campaign in 2017 (Reinhardt, 2018). Political topics more generally have also been studied and Choi etl al (2014), for instance, explored political discussions specifically for Korean Twitter users. NodeXL has also been utilised to study advocates and critics of the Hijab (a veil typically worn by women) on Twitter (Batet and Sánchez, 2018).

In an ever increasing and data driven world where social media platforms are generating swarms of content it is important to have access to tools, methods, and techniques, which can

be used to make sense of this data. These findings from the review of literature highlight the diverse potential of social media data for gaining insight into a far-reaching range of topics which could be applied to the news media domain.

It is also important to provide an outline the functional capability of NodeXL and some of the features it contains. NodeXL allows end-users to generate network visualisations from a range of data sources and one such source is Twitter. In the case of Twitter NodeXL can additionally generate a number of metrics associated with the graphs such as:

- The most frequently shared URLs
- Domains
- Hashtags
- Words
- Word Pairs
- Replied-To
- Mentioned Users
- Most frequent tweeters

These metrics are produced overall and also by group of Twitter users. This is because NodeXL has the ability to cluster discussion into a number of different groups based on the content that is shared. Thus, looking at different metrics associated with different groups (G1, G2, G3 etc.) it is possible to rapidly establish the diverse areas that users may be conversating about. NodeXL also hosts an online 'Graph Gallery' where users can upload workbooks and network graphs. Figure 1 below showcases the different network structures that can emerge on Twitter, and figure 2 provides a simplified view on the visualisation.
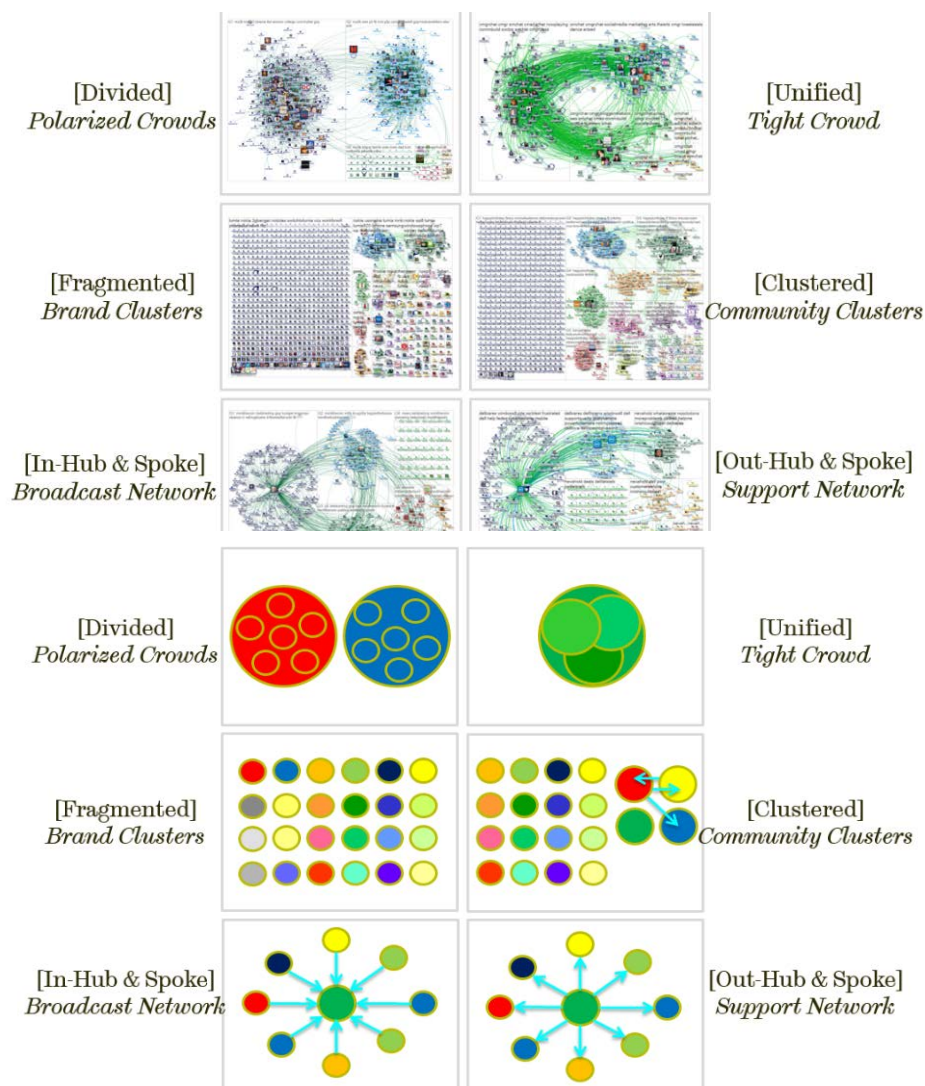
Figure 1 from (Smith et al., 2014)

Figure 1, from Smith et al (2014), highlights how distinct topics on social media social media can have contrasting network patterns. For instance in the polarized crowd discussion this may occur when the topics are split into two sets of users referring to two distinct topics, for instance, one set of users may converse about Donald Trump and another set of users may form their own group to converse about Hilary Clinton. The polarized crowd groups can be identified because two distinct groups can be observed within a network graph. Further examples could include Twitter users who are pro-abortion and users whom are anti-abortion when discussion surrounding abortion is analysed. In the unified crowd, referring back the

political analogy, users may converse about different aspects of an election which contains some overlap as certain users may be connected to each other. A unified crowd network is typical at academic conferences because discussion may overlap and Twitter users may already be connected to each other. The brand clusters shape would occur when users would, for instance, share an opinion or website link without being connected to one another. Popular news events which generate news articles may contain a sizeable isolates group because Twitter users will repost these articles. In community clusters users may form smaller groups to discuss sub-topics related to an overall topic. For instance, given discussion on a sports event Twitter users may begin new sub-topics related to the specific performance of certain players. Broadcast networks are typically found when analysing news accounts as these disseminate news which is retweeted by a large amount of users. In emerging news events newsrooms may be interested to examine the key users tweeting about a topic in order to determine key information diffusers. These users may be present among several subgroups and may contain news accounts, journalists, and opinion leaders. In the United Kingdom the Twitter networks of BBC News and Sky News, for instance, will resemble that of a broadcast network because their tweets are widely shared and retweeted. Support networks are those accounts which reply to a large number of accounts, for instance, the customer support of a bank may reply to a large amount of Twitter users to address their queries.

Reporting Network Metrics and Visualisations

Table 1 below connects potential goals of a newsroom to specific features in NodeXL which can be utlised to garner insight into discussion on Twitter. This is the first empirical study which explicitly highlights and connects overarching goals of newsrooms to specific outputs and our guidance is likely to have important practical uses during emerging events for those who work in the news domains.

Table 1 – Goals for News Teams analysing Twitter data

General Goals for Newsrooms	How to Achieve Goal	Example
Determine dominant external media narratives shared on social media during an evolving news event. And establish different discussions that are taking place based on an emergent new development.	Examine most frequently shared URLs, domains, and hashtags in NodeXL. And examine the different groups by examining and interpreting the most frequently occurring words, word pairs in order to understand the discussions that are taking place.	During a presidential election one of the candidates has their emails leaked. WikiLeaks (an international non-profit organisation which shares private information) shares this content on social media. News media may be interested in finding out the most shared URLs linking to the leaked emails, the domains referred to, and the hashtags that may be referred to.
Ascertain users who are concerned with an evolving news event.	Examine influential Twitter users by the metric of Betweenness Centrality, Indegree, and OutDegree.	In a similar example as above, news media organisations may wish to identify users on social media platforms such as Twitter who hold influence. That is users who are influential can be measured by Betweeness Centrality, users tweeting the most will have a high OutDegree, and users being mentioned the most will have a high Indegree.

The goals listed above were utilised alongside NodeXL to study a leak of emals during the 2017 French presidential elections, the narratives that were shared, and the users that were influential (Ahmed and Downing, 2017). Figure 2, below, provides an overview of the network visualisation that was created by analysing discussion on this topic.

Figure 2 Network Analysis of #Macronleaks using NodeXL
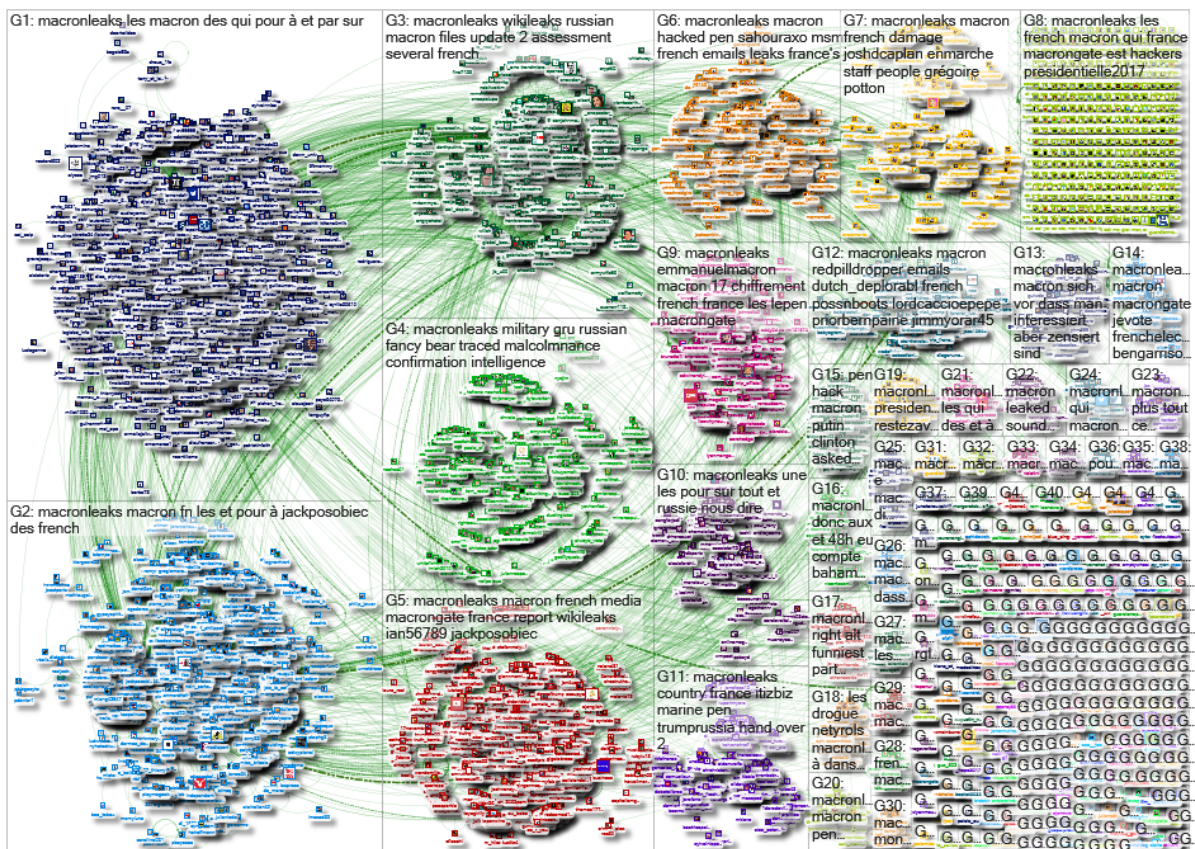
In this specific study by mapping the network of the #Macronleaks event (as shown in Figure 2) it was possible to identify Twitter users who were most influential. The most influential user consisted of the Twitter account by Wikileaks. A further Twitter user who appeared to be most influential was a Donald Trump supporter (as indicated from their Twitter bio) from the United States among a number of alt right users. The visualisation indicates how Twitter users in different groups have specific conversations in which they converse about, for instance, the keyword 'Russian' appears among the most used words because users would discuss whether the email hack was orchestrated by Russian hackers. Furthermore, the study found that a top word pair combination i.e., two words appearing together the most was 'WikiLeaks' and 'Macronleaks' which indicated the importance of Wikileaks as an information source which operates outside of the bounds of traditional journalism. The most

frequently used URLs relate to an independent blog covering the news story because at the time there was a media blackout preventing mainstream media reporting on the story. The desktop version of NodeXL will display a list of 'top items' such as hashtags, words, websites, and influential users among other top metrics. These items combined with the visualisation can also be uploaded to the NodeXL graph gallery which allows users to freely share their data and outputs and will be a useful resource for those working in the news media domain.

The earlier sections of this article highlighted the pressing concerns surrounding social media manipulation and the power of opinion leaders in disseminating news. Table 1 above has outlined how it would be possible to determine dominant external media narratives, key users and resources which would have the potential to highlight any potential social media manipulation.

Discussion

Social media has significantly altered the way in which citizens consume news and it has had a profound impact within the domains of social science research. Originally intended for personal usage social media began to be utlised in news and academic research. Indeed, there has been an exponential burst in the way social media has begun to be utlised as a means of communication. Moreover, its swiftness in reporting breaking news stories has significantly altered the way in which journalism is conducted. It has also provided citizens with the power to become creators of news and has increased the speed in which news is consumed. These developments have provided an ability to gather information and data on various emerging news topics. However, this paper argued that news on social media has been poorly mapped and measured and provided an overview and guidelines for measuring and mapping collections of connections from social media platforms. NodeXL utilised alongside these

guidelines could be put to use by journalists and researchers alike in developing a deeper understanding of social media reaction. This paper was the first empirical study which reviewed literature on NodeXL, and provided insight into the vast value of network visualisations as well as analytics for the news media domain. In the 21st century the way citizens communicate has significantly altered and new forms of technology such as social media has become common place. Henceforth, by examining content on social media dominant narratives can emerge and the users who hold the most power in regards to shaping the content of discussion can be understood. In an ever changing political landscape where social media is becoming ever more important in shaping political opinions and indeed potentially influencing the public it is vitally important to map and measure media narratives and influencers. Thus, this paper is likely to serve as a valuable resource for newsrooms whom can utilise the methods and techniques to better understand online content. By doing so news providers can also include a social media element to their stories and enrich content by providing insight into how online communities converse about certain topics and highlight how networks are structured. It must be noted that there are also further tools that can be used for social network analysis. Gephi (Bastian et al., 2009), for instance, is an open source software, which can be utilised for the purposes of graph and network analysis. UCINET is a general package for social network analysis (Borgatti et al., 2014). One of the benefits of using NodeXL is that it has a number of features which can automate the generation of the network visualisation and associated metrics. It is also worth mentioning a tool known as DiscoverText, a text-analytics tool, which can also provide key insight into social media data (Shulman, 2011).

Conclusion

This paper has provided an overview of some of the diverse uses of NodeXL from across a number of academic disciplines. The abstract provides an interesting starting point in reviewing the literature utilising NodeXL for research purposes. Now, as social media platforms become more and more popular it is critically important to study them. An interesting feature of NodeXL is that it requires no technical and/or programming knowledge which potentially allows it to be utlised across a wide range of disciplines from science and engineering, the social sciences, and the humanities.

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