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A Real-time Web Application for Tracking Twitter Exchanges about Research

Alistair Scott

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A REAL-TIME WEB APPLICATION FOR TRACKING TWITTER EXCHANGES ABOUT RESEARCH

Alistair Scott

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Background

Understanding how people engage with research is an increasingly important issue, and not just for researchers. Funders, the media, politicians and ultimately the wider public are increasingly concerned about value for money and maximising the impact of research investment. But establishing what kind of impact research actually has is no trivial task. A good place to start, however, is to try to learn something about how the ideas contained within research are being discussed in the wider world.

In the online world, public spaces have long been used as arenas for introducing, discussing and commenting on research. It was this that led to the development of the World Wide Web itself (World Wide Web Consortium 1989). Since then, the proliferation of platforms and services to support online debate, and especially the rise of social media networks, has meant that exchanges between people in the digital world are increasingly leaving information-rich electronic trails behind them. These data trails are, in many cases, freely available for public scrutiny. In principle it is now possible to capture and analyse some of these trails and to use this analysis to shed light on how people engage with research ideas in social spaces (Scott and Munslow 2015).

There are limitations to such analysis of course. Evidently, offline discussions cannot easily be captured electronically. Even capturing digital exchanges can be constrained by seemingly arbitrary idiosyncrasies of online technology. Moreover there is no single format or source of online data, but rather a multitude of sources. Some of these are harvested by search engines such as Google, while others can only really be comprehensively mined using bespoke systems provided by the social media platforms themselves. Nevertheless such analysis can sometimes provide a kind of forensic evidence that, though incomplete, can support and inform a broader narrative about how people are engaging with research. While they might lack quantitative rigour, such narratives can constitute powerful illustrations of the value of research and the contribution it can make to human development in its varied aspects (Hitchcock 2014). In short, they can help researchers tell useful stories about the wider relevance and importance of their work.

Systematically capturing these digital snippets requires the application of various kinds of online tracking technology. For example, the leading social media platforms provide Application Programming Interfaces or APIs. An API is a set of protocols, routines and tools for building software applications, and they have been increasingly developed for a wide range of online platform services, including Twitter and Facebook. Essentially an API is a kind of gateway into the data structure of an existing large-scale application. Such gateways allow independent programmers to build smaller, third-party applications that use the host application's data to provide functionality missing in the original. These smaller applications are typically low-cost, free or open source programmes that run as web-based or mobile applications.

Many commercial applications for monitoring and tracking online media do exist of course, but they can often be prohibitively expensive and are frequently optimised for use by businesses that wish to monitor public awareness of their brands. Where low-cost equivalents exist, they may fail to live up to expectations or be overly error-prone and unreliable (Scott and Munslow 2015). This can be a particular challenge for researchers and research organisations based in developing countries where resources may be scarce. And of course researchers and research institutions in developing countries are already significantly disadvantaged in comparison to their counterparts in developed countries. Institutional libraries in developing countries struggle to meet the cost of subscriptions to key

research journals, and researchers from the global South struggle to publish in those same journals because of editorial mandates that tend to favour research from Northern, developed countries (Chan 2012). Therefore, a simple, web-based application ('web app') specifically tailored to tracking online discussion of research, which is provided for free to users based in developing countries, could make a contribution to closing the gap between resource-poor Southern organisations and resource-rich Northern ones. We therefore concluded that we should attempt to design and build such an application.

Ideally such an app would draw on data from a range of online sources, including, but not necessarily limited to, social media platforms. At this stage however, because of resource constraints, it was concluded that it would be more cost-effective to optimise the analysis of data from one large and relatively comprehensive source, rather than try to accommodate multiple online sources. It was also decided that social media networks could be an especially useful focus because they are specifically designed to support online dialogue.

There are many social media platforms around the world but, in terms of levels of use and numbers of subscribers, the two giants are Twitter and Facebook. It is estimated that Twitter receives 310 million unique monthly visitors, while Facebook receives 900 million (eBizMBA 2015). But although Facebook may be the most widely used, it is not necessarily best suited to the type of data capture and analysis that we were attempting to harness. Indeed in some ways Facebook is almost a collection of private clubs and closed communities. On Twitter all user-generated content is made public by default, whereas Facebook users actively decide who can see their content. So compared to Twitter, a lower proportion of Facebook content is publicly accessible. Moreover, this different approach to accessibility may also be influencing the evolution of both the Twitter and Facebook APIs. Working with APIs can be technically demanding. They are not necessarily as simple to use as their parent applications. But developers often claim to have experienced particular difficulties with the Facebook API, especially in terms of being able to search for user-supplied content via hashtags. In March 2015, Facebook appeared to have permanently ended this type of searching altogether (Kamleitner 2015), making it technically much more difficult to retrieve the kind of data required for the type of tracking application that we were attempting to build.

By contrast, despite some quirks, the Twitter API is comparatively easy to work with. Furthermore, Twitter itself is widely regarded as one of the most influential social media platforms that currently exist, both for the academic world and beyond (Mandavilli 2011). Twitter also has a number of other advantages over Facebook and other social media platforms. For example, because it is essentially a micro-blogging platform, Twitter imposes strict size limits on user content. Twitter posts (tweets) are limited to a maximum of 140 characters, while Twitter profiles (descriptions of users drafted by users themselves) are limited to just 160 characters. In addition, hashtags (keywords or phrases prefixed with a '#' symbol) are central to the way Twitter is used. They are the standard mechanism both for searching Twitter and for maximising the probability that others interested in the same topic will see one's own tweets. One consequence of all these factors is that both tweets and Twitter profiles tend to consist of content that includes commonly used words and succinct phrases that users know (or believe) will be used by other Twitter users. This makes it relatively easy to carry out fruitful searches of Twitter data. As well as searching for tweets addressing specific themes, it is also comparatively easy to examine Twitter profiles to discern patterns of professional interests, roles or job descriptions among the people doing the tweeting. An app that successfully tracks this type of information has the potential to help researchers find out more about the reach of their research. They might, for example, be able to discover if their work is attracting the attention of professionals working in policy or practitioner arenas, the media or advocacy, or any number of other stakeholder groups outside academia. At the same time, despite the enforced brevity of tweets, it is possible for users to include long URLs (webpage addresses) without exceeding the 140 character limit, thanks to so-called 'URL shortening' protocols. This effectively allows users to enrich tweets

with larger volumes of content (including links to their own or other people's work). So academics and researchers can provide plenty of supplementary evidence to support their 140 character posts. For all of these reasons therefore, we concluded that Twitter could be the key primary data source for our app.

1 The ‘TwitterWeave’ app

Our aim was to produce a facility that could help researchers find out whether, and in what way, their research has been discussed on Twitter. We worked with a small team of web developers to build a prototype application which could then be made freely available to the general public on a live website, running on a Joomla content management system (CMS). The resulting web app (working title ‘TwitterWeave’) constructs interactive visualisations of Twitter searches to show how particular topics are being tweeted and retweeted in real time. It also combines this with information drawn from the profiles of the participating Twitter users to give some indication of the interests or occupations of the authors of each tweet. All of this information is plotted against a timeline, showing the chronological order in which successive tweets and retweets are made.

Usability, that is, the ergonomic design of the user-interface, should be a high priority in the design of all software. ‘The interface is the part of the system which the user sees, hears and communicates with. Depending on his or her experience with the interface, a computer system may succeed or fail’ (Sutcliffe 1988).

However, ergonomic design often requires considerable technical effort and extensive user testing, both of which can be highly resource intensive. So in practice the resources employed for user-interface design need to be proportionate to the total resources available and to the net present value of the whole project (Nielsen 2007). A ‘low-hanging fruit’ approach was therefore adopted during the initial development of the app, addressing the usability issues that were easiest to address. If, as is hoped, the app can be further developed in the future, a more comprehensive approach to human-computer interface design would be the main priority.

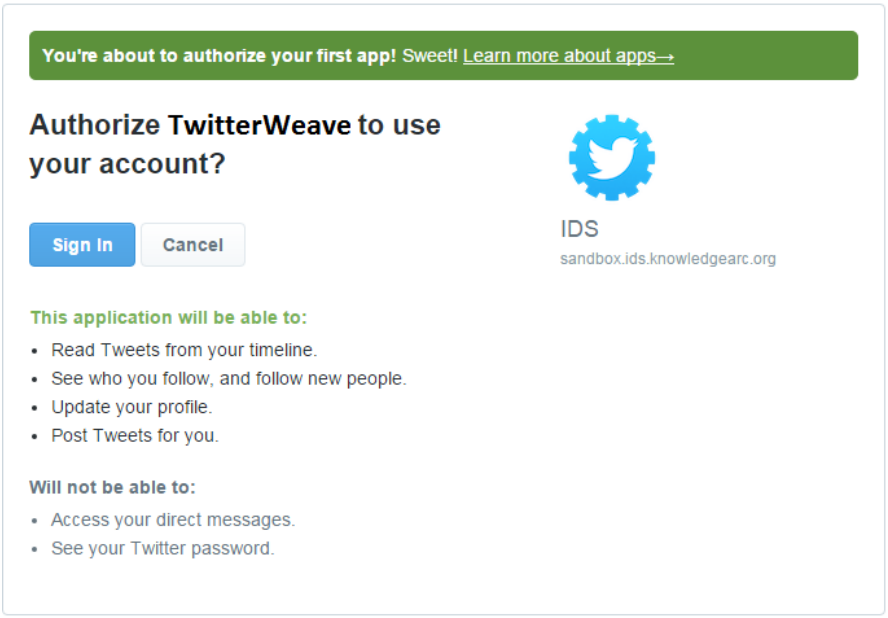
Nonetheless the team attempted to design a relatively intuitive and simple user-interface, consisting of four main screens:

1. Log-in
2. Search
3. Overview visualisation
4. In-depth visualisation

1.1 Log-in

The obvious way for the app to work with Twitter would be for it to make direct calls to the API. However, Twitter imposes tight limits on the number of API calls that any single application or user can make in any given period. Only organisations willing to pay a large fee can overcome this hurdle. So this direct approach was not an option in this design. But a workaround is possible, provided that the API calls are made from each user’s own Twitter account. Unfortunately this requires users to log in to the app using their own Twitter credentials, which is slightly cumbersome but unavoidable. However, because many other online applications have had to adopt the same approach, many users will probably have some experience of this procedure and the process itself is very simple. As the following screenshot shows, the user simply clicks a blue button labelled ‘Sign In’:

Figure 1.1 Twitter log-in

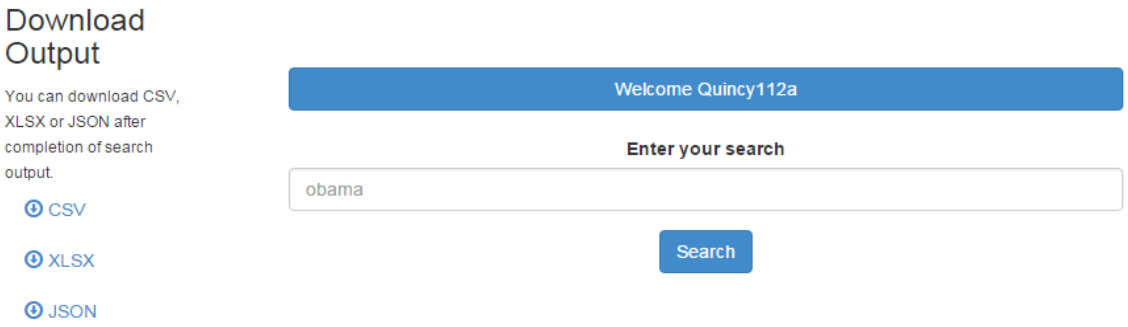


Source: Twitter Inc. (2015).

1.2 Search

Having logged in, users are then presented with a simple search box and they can enter any search terms they choose (words, phrases or hashtags) in any language:

Figure 1.2 Search



Source: Author's own (2015).

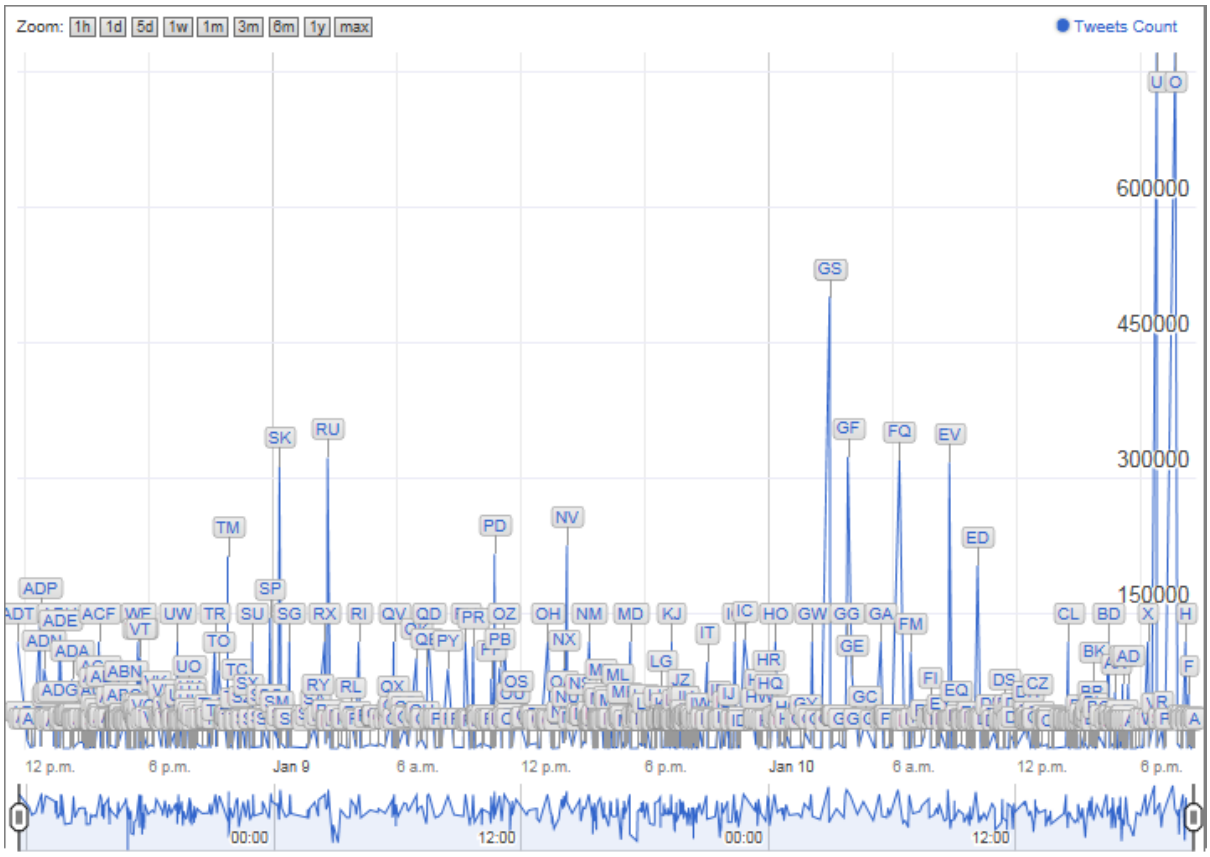
Depending on the search, of course, the number of results could potentially range from zero to millions. However, the core of the app is the visual display of data and so although it allows users to download search results for offline analysis (see below), it was important to ensure that the app's own visualisations do not become cluttered with data. It was also important not to exceed Twitter's own limits in terms of the volume of data which is permitted for a single user in any given time period. In addition, a search that generates a large volume of results requires more processing and therefore more time to complete than a smaller search. For these reasons therefore, the total size of the search is currently limited to a maximum of 100 tweets. If this limit is exceeded, an onscreen message appears, asking the user to narrow the search. Despite this restriction though, the evidence from our testing so

far suggests that this is more than sufficient for most situations. Tracking responses to research outputs does not usually seem to generate huge volumes of Twitter data.

1.3 Overview visualisation

The search results retrieved from the API are then initially displayed on an overview graph, which shows all relevant tweets as points:

Figure 1.3 Overview visualisation



Source: Author's own (2015).

Links between points indicate a 'thread' where a tweet has been retweeted. The horizontal axis is time and the length of the axis defaults to the length of time between the first and last tweets in the search results. Immediately below this axis is a variable slider that can be used to shorten the time period, thereby displaying a smaller number of tweets. This can be useful if, as in Figure 1.3, the search has returned a large number of results in a short time period.

The vertical axis is effectively a list of the authors of all the displayed tweets. Because this visualisation is a general overview of all the data from the search results, the authors' names are actually all hidden at this stage to save space on the screen. (The names are revealed in the in-depth visualisation shown below). However, this axis is not a randomised list but is delineated by the number of Twitter followers each author has, in ascending order from the origin. The reason for this is that the number of followers is often considered to be a crude proxy for 'influence', in the sense that the larger the number of followers, the greater the potential audience for that particular tweet (Romero *et al.* 2011). Also, having a large number of followers might imply that the author is generally considered to have a significantly high level of influence in the real world (consider for instance the 66.8 million followers for Barack Obama's Twitter account). In this way, users can get a quick visual sense of which tweets had the biggest potential audiences and were made by potentially the most 'influential'

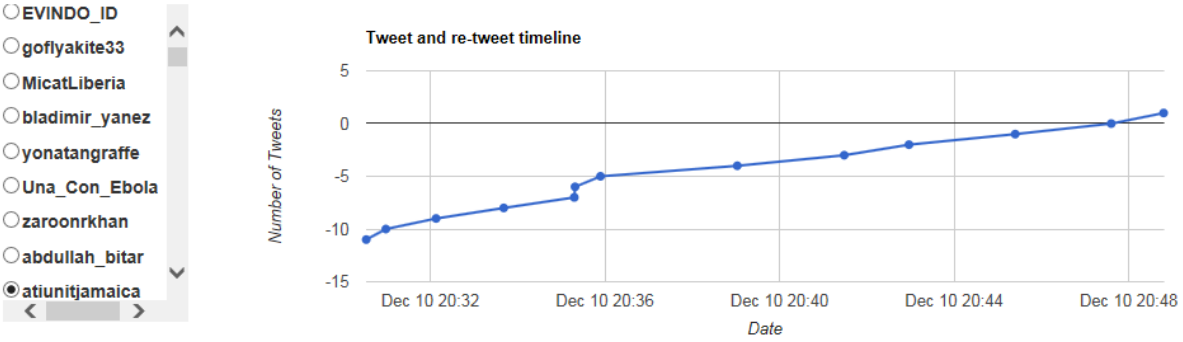
people or organisations. That said of course, this is only a proxy: the number of Twitter followers should never be taken as a definitive indicator of influence (if indeed, there is such a thing).

1.4 In-depth visualisation

By clicking and dragging the mouse, the user can also draw a box on the overview graph to select a smaller section. Clicking on this box produces an enlarged in-depth graph of just this section. This time, however, the objective is to allow users to hone in on individual tweets and threads. So, the graph is initially blank to keep the workspace free from clutter. Also the authors' Twitter names are now visible on the vertical axis.

Each name is accompanied by a radio-style button that allows the user to display only the Twitter threads specific to that author. Clicking on a button will plot a particular author's tweets, retweets and all related tweets (i.e. if the author were retweeting someone else then the original tweet is displayed and if the author's tweet was subsequently retweeted by anyone else, then those retweets are displayed). A line connects all these related tweets and retweets, thus creating a thread that shows how an initial tweet has been retweeted over time.

Figure 1.4 In-depth visualisation



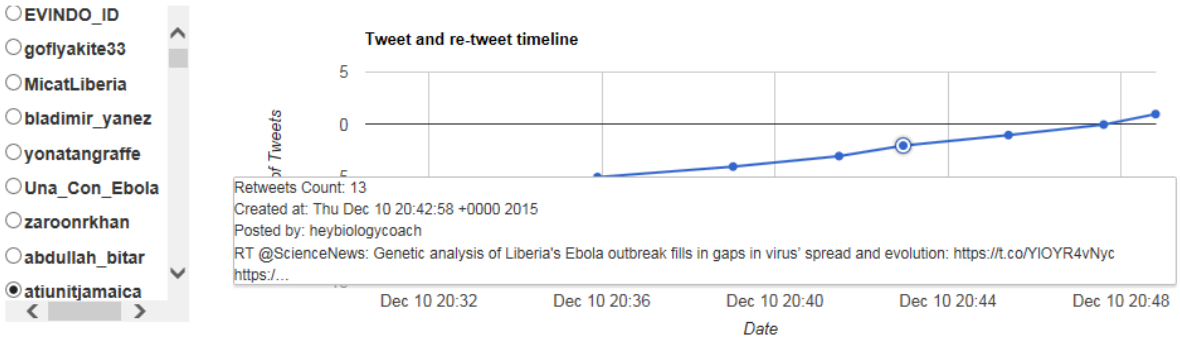
Source: Author's own (2015).

Depending on the search terms supplied by the user, a number of different Twitter threads may be generated for a single search. This is because different Twitter authors may post their own tweets on the topic and those tweets may then provoke responses or retweets from others.

Clicking on any tweet or retweet in a thread will open a window which displays a range of information, including:

- the Twitter author's name
- the content of the tweet
- the Twitter author's profile and geographic location (if known)
- the number of followers for this author
- the date and time of the tweet
- whether or not this is an original tweet or a retweet.

Figure 1.5 In-depth visualisation showing author window



Source: Author's own (2015).

Depending on the information provided by Twitter authors themselves, this information can provide users with a sense of the kind of people who are tweeting or retweeting relevant comments and opinions. It should be easy, for example, to identify instances where a recent research output has grabbed the attention of potentially significant individuals or organisations.

1.5 Additional functionality

Users can download the complete data set for each search result as a spreadsheet file. This functionality is provided by a menu on the left-hand side of the screen, which provides a choice of three common spreadsheet-friendly formats: XLSX (Excel Microsoft Office Open XML), CSV (Comma-Separated Values) and JSON (JavaScript Object Notation). This enables users to carry out their own offline analysis using any number of third-party applications, including spreadsheet packages such as Microsoft Excel or graphical visualisation products such as Tableau. Users can also download any of the graphical visualisations in standard image formats (such as PNG (Portable Network Graphics) or JPEG (Joint Photographic Experts Group)) for use in other applications such as Microsoft Word or PowerPoint.

2 Constraints

There are a number of technical issues within the underlying technology supporting the TwitterWeave app which, although not fatal, have nonetheless shaped and constrained the development and functionality of the final application.

2.1 Searches

As explained earlier, the volume of data produced by any one search is restricted for a number of reasons, including the limits imposed by Twitter itself. An additional Twitter constraint is that there is a limit to the age of the tweets that can be found in the search results, though this limit seems to be somewhat arbitrary and idiosyncratic. Normally, the limit seems to be a few weeks, but sometimes it can be only a few days, and occasionally tweets posted many months ago will mysteriously appear in a search. It is worth noting that because TwitterWeave uses essentially the same search function that Twitter provides through its normal Twitter interface, these particular constraints are the same as those experienced by users when they engage directly with their own Twitter accounts.

For the kind of research tracking envisaged, however, there is so far no reason to believe that these search constraints (including the current 100 tweet limit) affect the utility of the app in a significant way. During an earlier study, test searches for a number of research outputs and events were carried out using the Twitter search function and the search facilities provided by various media monitoring applications (Scott and Munslow 2015). This suggested that at least in the field of development research, typical Twitter activity tends to be relatively modest: dozens of relevant tweets in a given time period rather than hundreds or thousands. In some ways this is no bad thing because it produces a manageable volume of search data, which can be analysed and assessed in some depth without too much time and effort. The principle role of the TwitterWeave app is to be a micro-level tool that facilitates this process. It enables researchers, communications professionals and other users to construct narratives around the propagation of research ideas across social media. Quantitative analysis of large volumes of Twitter data was not an objective in the design of the app.

Good search results depend on the quality of the searches themselves and here the principles that apply to all online searching apply equally to the TwitterWeave app. The ideal search result is one with a minimum number of false positives, combined with the maximum proportion of available relevant data, but achieving this ideal is usually a matter of trial and error. The best results usually require several iterations: a number of searches each using slightly different combinations of words and phrases.

2.2 File saving

Although users can download each set of search results, or copy visualisations for use in other applications, it is not possible for users to save any of their searches or visualisations within the app itself. This is purely because of cost. Currently the app is designed as a free, public good, available to anyone with access to a computer, internet connection and web browser. A facility for saving searches is logistically impractical without introducing some cost-recovery or pricing mechanism. This is because however they are managed, saved searches will, at some point in the processing cycle, take up significant memory space on the web servers which run the TwitterWeave app. Because it is impossible to predict how many users will want to use the app at any given moment, an entirely free-to-use app would effectively require almost unlimited storage capacity. Any save function would require some mechanism both to control user demand and to finance the necessary additional storage

capacity. Some type of pricing system would be one solution. For example, it is relatively straightforward to determine the broad location of users via their internet service providers (ISPs). Although not totally accurate, such a system could form the basis of a kind of 'Robin Hood' pricing mechanism, whereby use of the app is free to users in developing countries, but users in developed countries would incur a very small charge. Such a charge need not apply to the use of all the functions of the app, but might be applied to saved searches or might only be levied after the user has carried out a certain number of free searches.

2.3 API interface

All serious applications designed for tracking social media rely, to a large extent, on the APIs of the platforms they are monitoring. Twitter has provided the software development community with a powerful, stable and coherent API with which to mine their data. However, like any API, it is not perfect and will not always produce successful responses (Fan 2012). We observed some small discrepancies between the documentation provided by Twitter and the actual performance of the API. Some potentially useful data fields described in the documentation for example, turned out to be almost always empty for no discernible reason. These kinds of issues required some ingenuity in order to develop workarounds. While none of these problems proved catastrophic, they did cause significant delays in technical development that in turn delayed the project as a whole and prevented us from carrying out full usability testing within the original timetable.

3 Next steps

At the present time, the TwitterWeave app runs on a test server. It will be moved to a live server in early 2016 for a public launch, accompanied by a publicity campaign devised with support from the Communications Team at the Institute of Development Studies (IDS). This campaign will focus on marketing the app to the intended user groups, which are broadly divided into primary and secondary targets:

- Primary targets:
  - Development researchers and research institutions in developing (Southern) countries
  - Development knowledge intermediaries in developing (Southern) countries
  - NGOs and advocacy organisations in developing (Southern) countries
- Secondary targets:
  - Donor organisations (global)
  - Relevant media outlets (global)
  - Development researchers and research institutions in developed (Northern) countries
  - Development knowledge intermediaries in developed (Northern) countries
  - NGOs and advocacy organisations in developed (Northern) countries
  - Researchers and research institutions in all fields, not only development research or the social sciences (global).

The primary target groups for marketing are all located in developing countries. There are a number of reasons for this (apart from the obvious fact that the focus of the IDS Strengthening Evidence-based Policy programme is development in the global South). One reason is the different levels of resources between Northern and Southern organisations. From our research we believe that the particular approach used by TwitterWeave is unique, but the type of analysis it provides could, in principle, be provided by customising the functionality of some of the large commercial media and social media monitoring packages. As we highlighted earlier, however, for organisations in developing countries with limited resources, even the basic licences for these packages can be prohibitively expensive. For example, conversations with representatives of four leading online monitoring products – Meltwater, Vocus, Talkwalker and Brandwatch – suggested an average price of £10,000 per year for a basic package comprising a small number of licences (typically around ten). So although the TwitterWeave app is designed for use by anyone involved in development research production and communication, it is particularly aimed at such people when they are based in developing countries.

Before launching and marketing the app, some additional usability testing will be required. Early in 2016 we aim to employ a small number of volunteer test subjects (with no prior relevant knowledge) who will be given a number of representative tasks to carry out using the app. As discussed previously, this will help to ensure a reasonable level of ergonomic performance, as well as revealing any technical issues. Once launched, the app will be closely monitored, both to keep a close watch on performance and to assess user demand.

4 Further development

This first version of the TwitterWeave app has only a modest range of functions. The priority during this phase was to demonstrate that with only limited resources, a genuinely useful and practical application could be built and made available to the wider public. However, there are many other useful functions that could be developed for the TwitterWeave app. Discussions with the Text Analysis Group at the University of Sussex's Informatics Department for example, are exploring the possibility of incorporating Natural Language Processing techniques to increase the power and precision of the app. At the less complex end of the technical spectrum there are relatively simple developments that might also dramatically enhance the app's power and functionality. For instance, one explanation for the high prices charged by the aforementioned commercial monitoring applications is that they require the manual indexing of thousands of websites and online sources in order to produce useful data for their users, and this requires large teams of staff. Automated search engines such as Google are no substitute for this human indexing. However, search engines can nonetheless generate useful data, especially when used in conjunction with other applications. Therefore a potentially powerful, but technically very simple, enhancement for the TwitterWeave app would be for each search to be simultaneously entered into both the Twitter API and into Google, with the results of both searches plotted against the same timeline. This could show where Twitter activity coincides with relevant events outside the Twittersphere. For example, an interesting narrative might be suggested when a sudden spike in Twitter activity coincides with related events revealed by an identical search on Google. Such media monitoring by TwitterWeave would be nowhere near as sophisticated as that offered by the commercial monitoring packages, but it would be nowhere near as expensive either. Indeed for most users it would be entirely free, which compares very favourably to the £10,000 annual price tag of the commercial packages.

5 Sustainability

The current intention is that the TwitterWeave app will continue to run on a third-party cloud-based web server (external to IDS). If usage is fairly modest this has no real resource implications in the short term. However, over time both the app and the cloud server on which it is running will incur periodic maintenance and update costs. Therefore, if the app is expected to continue running for a significant period of time, and especially if user demand for it grows significantly, then some small, additional resourcing will be required to keep it operational.

Regardless of the intended users and purpose of the app, it is important to remember that a free-to-use application of this nature can be used by anyone to track any kind of publicly available online information, far beyond the realms of research. There is nothing intrinsically problematic about this. Indeed the more widely the app is used, the more widely known it will become. However, if the app is successfully taken up by significant numbers of users, regardless of who they are or what they are using it for, there may well come a point where user demand is placing such high loads on the web servers that extra capacity will need to be provided, and this would require additional resources. If usage does grow significantly, and if it becomes clear that much of this is for general searches that are completely unrelated to the purposes for which the app was built, then the argument for introducing some kind of pricing, at least for some groups of users or types of use, becomes much stronger.

6 Conclusion

The aim of the project was to design and build a tool to help researchers, knowledge and communications specialists, advocacy staff and other users to track the propagation of research messages and ideas across online and social media spaces. The aim was to develop an application that contributes to the construction of narratives about what is being discussed, when and by whom. Such narratives might then provide insights into how particular people, professions and organisations are engaging with particular kinds of research.

Such a tool was successfully built and took the form of a web-based, Twitter-mining application, under the working title TwitterWeave. This application enables users to search for and display tweets and retweets related to particular areas of interest. It allows them to see these tweets and retweets as connected ‘threads’ plotted against a timeline and crucially it also allows them to easily see detailed information about the authors of those tweets. Depending on the information supplied by the authors themselves in their Twitter profiles, this information may include details about their professional interests, jobs, employers and geographical location. It also shows the number of Twitter followers for each author, a number that is often taken as a proxy for ‘influence’.

A publicity campaign will accompany the launch of the app in early 2016 to target key user groups. Levels of use will be closely monitored to determine the level and type of user demand for the app. If demand appears strong then ways of sustaining and further developing and improving the app will be explored.

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Brighton BN1 9RE

T +44 (0)1273 606261
F +44 (0)1273 621202
E ids@ids.ac.uk
www.ids.ac.uk