Using Visual Signatures to Classify Links on Twitter

ABSTRACT

In this research we trace the propagation of links on Twitter, a popular microblogging service. Here we describe how users pass on links in Twitter. Links can be passed on in Twitter with or without attribution (using the 'retweet' mechanism) and we create a graph to visualize how links are passed through the social network. Findings show preliminary evidence that various types of links have different visual signatures. We create visualizations or graphs for user generated links, marketing links and spam links noting characteristic identifiers and discussing what these graphs tell us about how information is exchanged on Twitter .

Author Keywords

Twitter, Memes, Link Propagation, Online Social Networks.

ACM Classification Keywords

K4.m. Computing Mileux, Computers and Society: Miscellaneous.

INTRODUCTION

The summer of 2009 saw Twitter, a microblogging service that allows users to create public blog entries in 140 characters or less, become a primary source for news reporting from the Iran Election, serve as a sounding board for reaction and tribute in the days after Michael Jackson's death, and also distribute countless messages about users' current emotional state, location, etc. [5] One of the many methods of communication on Twitter is through the passage of links between users. In this preliminary research we visualize how links are passed through the network in microblog posts or 'tweets' and also provide early evidence that there are different types of link-memes characterized by very different visual signatures. By studying how information is passed on research demonstrates how (and how effectively) different users like marketers, spammers and individuals broadcast content on Twitter.

Although there has been work to see how memes are passed on in blogs [4]. Less work focuses on Microblogs which are particularly interesting because they allow for attributions. There is some evidence from the work on tracing memes in blogs that different "types" of memes (or in this case links) can be identified[2].

Here we will first describe how microblog posts are passed on and attributed. Then, we will describe how we selected particular links to follow. Finally we will show the visualizations of how the links propagated over time showing preliminary evidence that this visualization allows us to identify typess of links from user generated, marketing and spam.

CHI 2009, April 4–9, 2009, Boston, Massachusetts, USA.

TWEETING AND RETWEETING

Links are passed from Twitter user to Twitter user when a link is tweeted by User1 and is seen by User2. User2 then has the four options. The first option upon seeing a link in a tweet is to ignore it leading to a dead end. The second option is to visit it, but not bother to tweet or retweet about it. The third option is to retweet the link with attribution, and the last is to tweet the link without attribution. These options represent action steps taken by the user upon seeing a link. Users could take these same actions if they saw a piece of media (e.g., a YouTube video) outside of Twitter.

Attributed repetition usually contains a reference to another user, either the originator of the message (in our case link) or to the last broadcaster of the message [1]. Consider the following tweets.

User1: I love this link http://www.foo.comUser2: RT @User1 I love this link http://www.foo.com

User3: I love this link http://www.foo.com (via @User1)

User4: RT @User1 I love this link http://www.foo.com (via @User2)

User5: Awesome link http://www.foo.com

User1 is the original broadcaster of this tweet. Users 2 and 3 have retweeted User1, it is ambiguous who User4 is retweeting. The syntax for retweeting varies based on the user and the Twitter client that they are using. Though RT @username seen in User2's tweet above is an accepted convention, some Twitter clients use the via @username syntax shown in the User3 tweet above. In User4's tweet the ambiguity comes from the double attribution, it is unknown whether User4 saw User2's or User1's tweet first hence proper attribution is difficult [1].

In addition to the attributed repetitions of a link we also captured unattributed repetitions of a link such as User5's tweet above. Since he/she is connected (through their social network in Twitter) to the other users, User5 may have seen

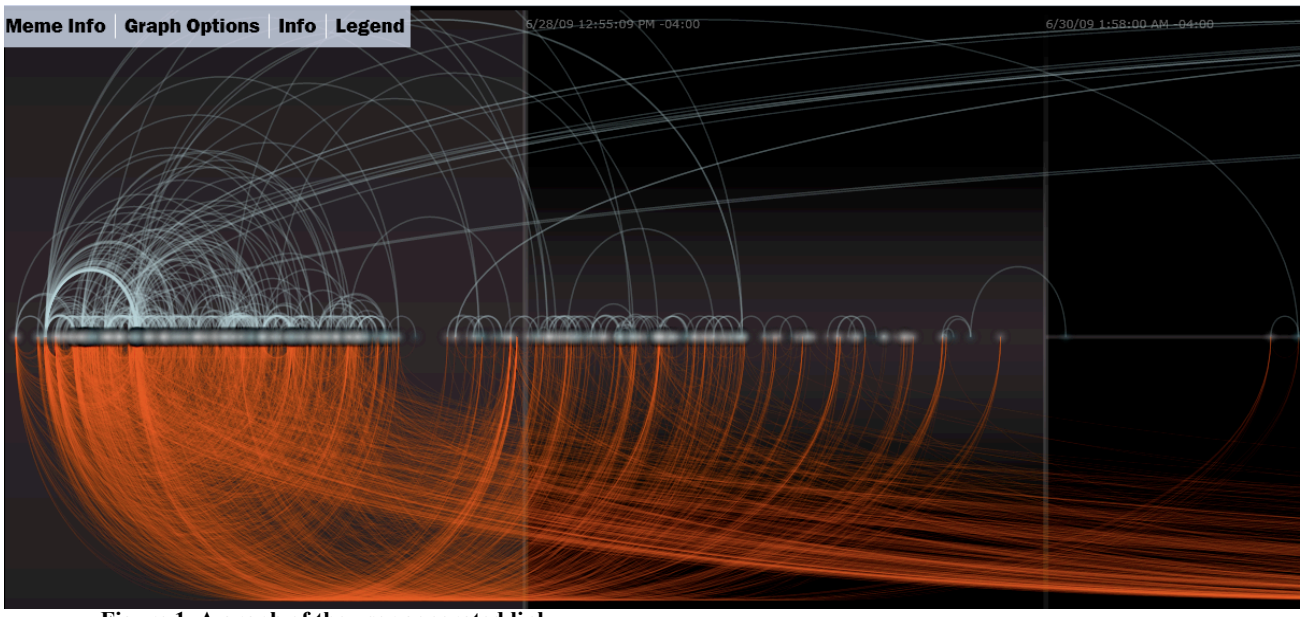

Figure 1. A graph of the user generated link www.billietweets.com, a tribute to Michael Jackson (full graph not shown for space reasons).

the link in their Twitter feed and stripped attribution or they may have been influenced by an outside media source.

Sampling

Understanding this mechanism we collected a sampling of tweets about each link, we estimate collecting 25% of all the Twitter posts about a particular link . Using these, we created a graph for each link with a progression of tweets over time, drawing links between tweets based on whether they were retweets. To account for the ambiguity of tweets attributed to multiple people, we simply gave attribution to all the people mentioned with retweet syntax (RT @, via @, from @, Thanks @, etc).

A more complicated problem arrived when attempting to identify whether attribution was stripped from a tweet. Because a Twitter user has a collection of people that they are following we can assume they read the stream of tweets coming from these people. We used Twitter's API methods to see whether a user was following any of the other users that had tweeted about the same link before them on the graph. Using this information we were able to draw links between people who had been following other people on the same graph. If users are linked we assume that they saw unattributed links in their Twitter stream.

GRAPH METHODOLOGY

Using this corpus of Tweets we are able to plot graphs of links in interesting categories to see their growth and movement over time. In our graphs we create relationships based on how a person is tweeting about a link. Consider the four tweets below.

User1: "I loved this video http://bit.ly/34542"

RT @user1 I loved this video http://bit.ly/34542"

User3: "Dude so cool http://bit.ly/34542"

User4: "Great video http://bit.ly/34542"

On our graph the first three tweets will be assigned nodes drawn as circles on the central x-axis of the graph with respect to the time they were tweeted. Because User2 has explicitly assigned attribution to User1 we can draw a strong link or blue line between their circles. At first glance User3 seems unconnected to Users 1 & 2, but if we look at who User3 follows on Twitter we can see that User3 is following both User1 and User2. Using this information we draw an orange line or weak link between User 1 and User3 as well as between User 2 and User 3. User3, even without explicit attribution to User1 or User2, could have come to know about the link from them. Because he is following both of them and has tweeted after their tweets about the same link a likely scenario is that User3 saw the link in his feed, visited it, saw some worth, and then tweeted it. In the case of User4, he has neither given explicit attribution for his tweet nor is he following any of the people that have tweeted about this link. In addition no one further down the chain is following him, nor have they retweeted him. Because he is a dead end for the link because no one is linked to him in any way we don't plot a circle for him, instead he is used an indicator of tweet volume in the background as purple haze.

The elements of the graph then are as follows:

Circles=tweets that are connected by at least one weak or strong link to another tweet.

Blue lines = strong links, if person a explicitly attributes a tweet to person b then we can draw a strong link."

Orange lines = weak links, as all members of the set of tweets have tweeted about the same link. If person b tweets about a link without attribution but is following a person who tweeted about the same link earlier a weak link is drawn.

Haze = display of tweet volume over time, the more haze the larger the volume of tweets in that time period

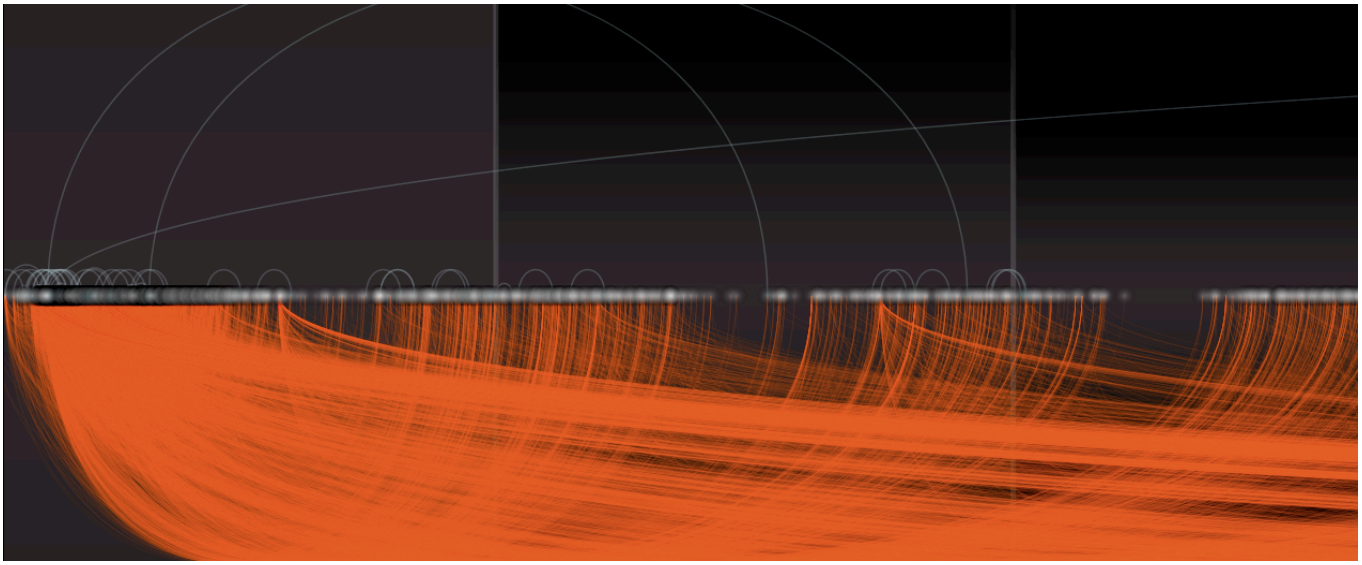

Figure 2. A graph of the Indonesia Unite link which placed a ribbon on your Twitter photo to show your support for the fight against Indonesian terrorism.

Following this methodology we were able to graph links across several categories to try and distinguish some of their characteristics. As this is early work, our sample size is small, and we discuss relevant categories.

LINK CATEGORIES

We chose to look at three categories of links: user generated memes, marketing links, and spam links. These categories were generated because they were established as important by prior research [3] and they represent a large portion of links in Twitter. The specific links selected were selected because they were rated as the most popular links in these categories at the time of the study. This would give us the most robust findings and allow us to best visualize the model and in the future allow us to train our model.

User generated links connected to a piece of media not related to an outside marketing effort and were usually generated by just one or two people. These links tend to be Youtube videos, comics, spoofs, or other end-user content. Marketing links are used by companies and individuals to promote a new product, host a giveaway, or give visibility to a cause. Finally, spam links are composed of cash spam links, porn links, gambling links, and links designed to make the spreader cash through clicks. One could say that the goal of spam and marketing links is the same, but we used a common sense litmus test tell which belongs in which category. If it would most likely be considered spam in an e-mail inbox it would fall into the spam category of our links.

USER GENERATED LINKS

After creating visualizations for seven user generated memes including a YouTube video, a popular photo, a joke, etc., (e.g., Figure 1), we were able to notice a pattern amongst this type of link. These graphs seemed to be most connected both in terms of retweet connections and following connections. In general there is a period of high activity in terms of retweeting as shown by the left hand side of Figure 1, and then that activity tapers off, however there are still users who tweet without attribution about the link after this initial period of high activity. Some of these users are following several people who have tweeted about this link. If we look at retweeting merely as source attribution it can be said that after a while the knowledge of this link becomes public domain and that is why they do not retweet anymore, but rather just tweet.

In general we found that most people only get retweeted once. That is, person A will be retweeted once by person B, but then not again. However, the pattern does not apply in the case of some celebrity and well known tweeters with a lot of followers. These individuals have the ability to get retweeted multiple times, and often hundreds of times. These celebrity tweeters often act as pushers who can cause a meme to explode. For example a Youtube video tweeted by Ashton Kutcher resulted in hundreds of retweets of that link by Kutcher's followers. Even if the followers do not tweet or retweet the link they can still go and watch it contributing to the notoriety of the video.

MARKETING LINKS

A second category of links is marketing links. These are links used by companies and individuals to promote a new product, host a giveaway, or give visibility to a cause. Eight marketing links were visualized and these links fall into two categories, those propagated by machine generated tweets and those propagated by retweets.In machine tweeted link a user performs an action on some web site outside of twitter but gives the site permission to post a one-time tweet on the user's account.

For example users can turn their icon blue in support of Smurf Day, by visiting to supportSmurfDay.com. After entering their twitter ID and password, their icon is turned blue and the service has automatically tweeted a message "Want to support Smurf Day too? Go to supportSmurfDay.com." The meme is propagated when one of their followers sees the link and repeats the process. For this type of link, clicking on the link and allowing it to tweet on your behalf replaces the action of tweeting or retweeting. We noticed that in graphs of machine generated

links, there is very little retweet activity (Figure 2) even when there are a high volume of tweets. Instead the links are moved along the chain by unattributed links resulting in a large amount of orange connections. This condition makes sense because there would be little point in retweeting your support for Smurf day if you could not be bothered to turn your icon blue yourself. This same pattern also held for more commercial marketing tweets.

In the retweet-based marketing meme, a user must retweet a message in order to be given a chance to win something in a giveaway. Not surprisingly, in these types of situations there are many more strong links.

Within this category of Marketing tweets also fall the "gain twitter followers schemes." Originally we had coded these as spam, but in fact their graph characteristics indicate that they are not in fact spam but more akin to the machine generated marketing memes. In these types of schemes, the user is asked to give the site access to add a bunch of people to the people you are following. These people are generally the people who have just used the site before you. It will then tweet out that you have used this service and others should try it. If you have participated then you also get added to other users following lists, and thus gain more followers. It is because these sites generate a machine tweet that they follow the same rules as a marketing type of link.

SPAM LINKS

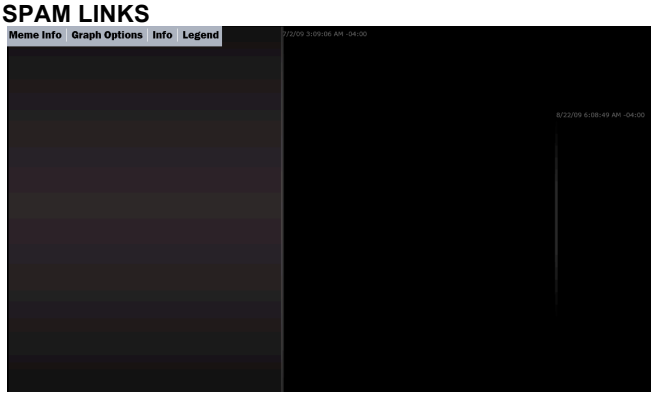

Figure 3. A graph of a spam link

The final category of Twitter links we looked at was spam memes with promises to make cash now and find your appropriate sex partner now. Only two spam links were visualized but in looking at these memes we noticed one very marked thing. There just isn't much to look at (Figure 3). In fact the graphs were quite barren. There was a volume of tweets in the thousands, but most of them were unconnected to any other tweets in any way. This could provide an early signature into codifying tweets as spam. If there is a link with high volume and extremely low connectivity then there is likelihood that it is spam. We hypothesize that this is due to the fact that spammers can create thousands of unconnected accounts, and then fire off a blast of spam. Alternately the spammers could be creating these accounts and blasting out spam and being quickly shut down by the Twitter spam team.

CONCLUSIONS

The spread of link based information through the Twitter network is varied, and our technique sought to classify link traffic based on certain visual signatures in their tweet and retweet patterns. Though this work is preliminary, we were able to find some visual signatures to various types of links. This enabled us to explain how various messages spread and also provided evidence that certain users propagate memes much more effectively than others. While this idea has been suggested, this is the only known work to provide concrete evidence and show how we can identify both helpful and harmful users. We would like to further this work over a larger dataset, as well as with more categories of links. We also would like to be able to come up with a model that would allow us to classify links mathematically not just visually.

ACKNOWLEDGMENTS

Anomymized in this version.

REFERENCES

1. Boyd, Danah, Golder, S., and Lotan G. Tweet, Tweet, Retweet: Conversational Aspects of Retweeting on Twitter. In *Proc. HICSS-43 in January, 2010*.
2. Gruhl, D., Guha, R., Nowell, L. D., Tomkins, A. Information diffusion through blogspace. *In Proc. WWW,* 2004.
3. Java, A., Song, X., Finin, T., & Tseng, B. Why we twitter: understanding microblogging communities. *In Proc. KDD,* 2006.
4. Leskovec, J. Backstrom, L., & Kleinberg, J. Meme-tracking and the dynamics of the news cycle. *In Proc. KDD,* 2009.
5. Twitter website, http://twitter.com, September 9, 2009.