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Twitter: Roots, Influence, Applications

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Contents

Abstract	ii
1 Introduction	1
2 A Brief History	2
3 Twitter: Under the Hood	5
4 Twitter Architecture	6
5 Application Domains	7
5.1 Marketing	7
5.2 News	9
5.3 Education	10
5.4 Crowdsourcing	10
5.5 Enterprise Microblogging	11
5.6 Alert Systems	11
6 Third Party Applications of Twitter	12

Abstract

In this report, we are delving into the world of 140 characters: microblogging. This fascinating world is constantly changing and evolving into something more complex. Nobody can see where it will take us yet, but for many, Twitter is only the tip of an iceberg, a gateway to something unknown as DOS was to the Windows. While the world is still contemplating its possible future, many researchers took a hands-on approach, writing influential papers on Twitter.

More than just mentioning those papers, we are giving the basics of microblogging, explaining Twitter.com to details, saving you from the trouble of connecting thousands of dots on Internet with this report.

It was both breathtaking and intimidating to read and record all articles and papers on Twitter and microblogging. It was breathtaking, because of the influence of microblogging in many fields ranging from news reporting to alert systems and education. It is intimidating as well, because almost all sources are volatile. For the report, we had to mention many online blogs, newspaper articles but they might disappear or be moved on Web. We do not see this as a shortcoming in the report; as the very name of Twitter comes from chirping sounds of birds, it is only fitting that our sources, just like those chirping sounds, would be a part of our world for a short time and disappear, leaving us with new notions, like ambient intimacy[4].

1 Introduction

Everyone will be tuned in to everything that's happening all the time! No one will be left out. We'll be all normal! [1]. These lines were published in a cartoon by Robert Crumb in 1960's, but he was wrong to visualize wires attached to our heads. Current day microblogging has its popularity thanks to Twitter.com, but roots go deeper than that.

The real time text messaging began with Instant Relay Chat (IRC) in 1988. IRC was mainly designed for group communications, but also served as a basis for one-to-one communication. IRC was a great success and had a very similar period to Twitter's famous Iran election coverage when it was used to break a media blackout by Soviet Union in 1991. Popular characters that are used in microblogging, such as # and @, have their roots from IRC.

Another push towards a microblogging community came with mobile phones. With mass production of mobile phones starting from 1990's, mobility became possible and text messaging without a computer gained popularity. Soon after, companies started to push for new applications that utilized mobility. Mobile applications for instant messaging or news reports were developed. The main issue that surrounded mobility was to enable people to share information and collaborate.

Recently, researchers have been analyzing the user motivation to use microblogging and searching sites. A study by Broder shows three basic kinds of search queries: navigational, informational and transactional [2]. Navigational queries are performed to reach a particular site the user is looking for. Informational queries are used to find resources on the Web. Transactional queries are used to locate shopping or download sites where further interactions would take place.

In one of the first studies about microblogging, Java et al. aim to find the reason why users post microblogs on Twitter [3]. The paper lists microblogging users' intentions as *daily chatter, conversations, sharing information and reporting news*. Yet, the major reason for microblogging comes from a need to reach out to new, interesting and even expert people that we do not have a chance to meet in real life.

Researchers [4] call this ambient intimacy, and the notion addresses a new trend in public. So far for human relations, an approximation of 150 people is given as a limit to have stable social relations with. This number is called Dunbar's number, and it is named after the British anthropologist Robin Dunbar, who theorized this limit in relation to the neocortical processing capacity of human brain.

With microblogging, this number can be obsolete. We need stable social relations with people to exchange information, emotions and mundane things. What if there is a way to receive information and all the other things without getting to know the other person? Microblogging brings a *personal API* to us, and we can use it to explore minds from everywhere. The relation is there of course, but it is more of an *Intermittent, one-way, more of a crush than love; the feeling of a shared relationship without it being shared, a benevolent form of stalking* [5].

Microblogging offers a way to get past Durban's number. With the advance of search engines, people can find resources ranked in an order that is based on a majority usage rule, yet sometimes an expert's view, or an influential person's ideas might be worth more than all other people's. However, we do not have the required time, energy and mobility to find these people. Microblogging sites eventually address this desire by simply giving

users a chance to explore the world's people.

Apple fans no longer need to be friend with Guy Kawasaki to learn what he thinks, likes and reads. Like many other celebrities, politicians and sportsmen, Guy Kawasaki has a personal API on twitter. Even for our relation with the people around us, microblogging gives us a peek at their lives, it increases our interaction level with them. When carefully observed, the future of microblogging can be seen in the Japanese mobile phone culture, *keitai*.

The Japanese text messaging, with a 1000 character limit that is bigger than usual, provided the Japanese youth with a rich character set that can visualize moods, actions, and opinions. In Japan, mobile phone usage has gone to the point of being banned altogether on campuses and public places. Twitter on the other hand, provides us with a smaller text space than usual, but the space can include links to other texts, pictures and videos.

What keitai enabled with characters are also enabled with links on twitter, and furthermore, unlike text messaging, microblogging posts can be seen by more than one people, reacted upon, favorited and re-posted in public. Whether microblogging will be banned in public yet remains to be seen, but we are not that far away from the activity level of keitai culture.

2 A Brief History

“When you can measure what you are speaking about, and express it in numbers, you know something about it”, Lord Kelvin.

A web 2.0 project, Facebook.com established a status update field in June 2006, but it was Twitter that took status sharing between people to our mobile phones four months later. First named as *Status*, then as *Twtr*, Twitter has been evolving in its creator Jack Dorsey's mind since 2000. Dorsey wrote an application in 2000 that checked an email address for updates and notified his friends.

Dorsey had limited resources until 2005-2006 when SMS took off in USA. In its essence, Twitter is a virtual implementation that mimics how people move in a city. As Dorsey explains, *“Twitter has conceptual roots in the world of vehicle dispatch – where cars and bikes zooming around town must constantly squawk to each other about where they are and what they're up to”* [6].

What followed Dorsey's interest in observing movements was a Web 2.0 microblogging site called Twitter. Twitter has gone beyond status sharing and now become more of an information sharing and news reporting medium. Twitter started its journey in 2006, but its fame started to spread after the South by Southwest festival in 2007. In the event, company set up user accounts for the participants, and used big screens streaming tweets from them in the conference simultaneously.

The effect of the conference was huge for Twitter. According to a report by HubSpot in 2008, despite being functional since 2006, Twitter had its 70% of users joined in 2008, and an estimated 5-10 thousand new accounts were opened per day [7]. In 2008, 35% of users had ten or less followers and 9% of users did not follow anyone at all. 80% of users had a bio specified on their profile. In 2008, Twitter had around 4-5 million users and

Twitter had grown 600% in 2008, making it a top 1000 website in web traffic.

The trend of growth for Twitter has continued since then. In 2009, HubSpot published a new report and the report gives an astonishing 18.0000% growth rate of users, compared to 600% of 2008 [8]. The number of users who are not following anyone jumped to 55.50%, and the number of users who has a bio declined to 24.14%. According to this new report, 79.79% failed to provide a homepage URL, 68.68% have not specified a location and yet more interestingly, 54.88% have never tweeted. Of all users, 52.71% have no followers. By some definitions in the report, 9.06% of all users are inactive.

A discouraging statistics for Twitter is about the inactive user rate, and by correlation, the user retention rate. A report by Nielsenwire showed the retention rate of Twitter to be 40% and well below those of other popular web sites like Myspace and Facebook [9]. Soon, a big amount of criticism of the report was received from the Twitter community for the report's lack of taking Twitter applications into account. Nielsenwire responded by publishing another report that also looked into thirty other applications and web sites that feed into Twitter [10]. The dismaying results of the new report show the same 40% user retention rate for Twitter. The report concludes that if Twitter wants to continue its popularity, it should establish a higher user royalty.

When questioning the accuracy of retention rate in the Nielsenwire report, a point can be made by arguing the metric that is used. Java et al. [3] uses a metric for Twitter that is based on a study by Kolari et al. [14]. Definition of activity is given as "A user is considered active during a week if he or she has posted at least one post during that week". This metric only takes posting action into account, yet, in a microblogging case study Bohringer et al. found that even the users that do not contribute greatly to the discussion(i.e. do not post microblogs) can be aware of all interactions (of their friends' and some other in Twitter) within the microblogging site [15].

In this case, if Nielsenwire used user posting as the metric, the accuracy of the results can be very doubtful. A better metric would be a combination of user posts and user logins, but this metric can only be evaluated accurately by Twitter itself, as third parties cannot record all user logins.

Another point involves the very nature of the Twitter activity. Twitter has faced larger traffic during big events like Mumbai bombings in India or US elections. Such sporadic events boost Twitter traffic not only by exciting frequent "posters" to post more, but also by drawing "inactive" users back to the site to observe the event and contribute to it. In this sense, a user cannot be regarded lost, as is the case with other web sites, because her inactivity can end in the face of an event that draws her attention. Hence, account removals due to "inactivity" should not be performed in Twitter.

In contrast to other networking sites, being able to use Twitter without establishing a strong friend set first remains a true asset for Twitter, but this asset must be regarded as a double edged sword.

From the user loyalty point of view, The 2009 HubSpot report has some encouraging points. The sense of community is increasing as people gets acquainted with the service and starts looking around to bond some new relations. 1.44% of all tweets are retweets, 37.95% of all tweets contain an "@" symbol (mentions), 33.44% of all tweets start with an "@" symbol (replies). According to the report, week days have more tweets, and Thursday has the most traffic.

Another report by Pear Analytics contributes in some other dimensions [11]. Cur-

rently, Twitter does not disclose its user numbers, and all number estimations are made using the third party application results or other web sites' tools. The report gives the total number of Twitter users in USA as 27 million. %55 of these users are male, 48% is between 18 and 34 ages, and %1 of users contribute 35% of total visits. According to the report, only 27% are regular users.

The report confirms HubSpot's results about the Thursday traffic, but classifies this traffic as consisting of 42.50% "pointless babble". In general, the report classifies all traffic as 3.60% news, 3.75% spam, 5.85% self promotion, 40.55% pointless babble, 37.55% conversational, 8.70% pass along value.

The study also reports that 5% of all users generate 75% of all tweets. This is in accordance with a report from Harvard Business Publishing's blog [12]. The blog shows Pareto principle on Twitter. The Pareto principle (also known as the 80-20 rule) states that, for many events, roughly 80% of the effects come from 20% of the causes [13].

According to the Harvard blog, the top 10% of prolific Twitter users account for over 90% of tweets. On other networks, 10% of users account for 30% of all production. The blog's headline, "Men follow men and nobody tweets" marks a big difference of Twitter from other networks. On other networks, most activity is focused around women, and men follow or request friendship with women even if they do not know them, and women follow women. Twitter, in this aspect, follows a very different pattern because men follow women with 35% and men with 65%.

A recent hot topic about Twitter has been the teenage usage of Twitter. A then 15 year old Morgan Stanley intern, Mathew Robson, wrote a very interesting report on media, Internet and Twitter [16]. The report is hailed as one of the best reports from Morgan Stanley in recent years. Main difficulties, he wrote, evolve around the privacy issues, because unlike other networks, anyone can follow anyone on Twitter. Teens see Facebook as a better Twitter, as Facebook has status sharing too. Twitter always has an edge with its sms service, but this advantage is negated by the fact that cost of text messaging to Twitter is an issue for teens.

Twitter's user profile also drives teens away from the site. Teens do not have their friends on Twitter, and no one is looking at their profiles, so microblogging a post that nobody will read is not an alluring activity. As a blogger writes, "After all, who wants to be the only person they know on Twitter? It ain't fun" [17].

Twitter has seen a rapid growth in the western sphere, and cities like London, New York and San Francisco generate the largest traffic on the site [18]. Top 100 cities list is dominated by US, with the first non-USA city being Toronto, Canada. Tehran, Iran is 18th on the list, making it the first non-western city. As we recall the usage of Twitter in election protests in Iran, this does not come as a surprise. Tokyo, Japan, once in top 10 in 2008 [19], now enters the list as the 21st city. Tokyo is important, because Twitter made its first effort to open up to the world by creating a Japanese version of Twitter. The site has been a success, not only in its traffic, but also as the first monetizing opportunity for Twitter with its ads sections [20].

3 Twitter: Under the Hood

Twitter's success can be attributed to two main factors; elegance in design, and simplicity in adding your own improvements to Twitter. Elegance is due to the character limit. Twitter names microblog posts from users as tweets. Each tweet has a 140 character limit and this feature was inherited from text messaging. The original 160 character SMS limit was reorganized into 20 character username and 140 character post fields.

A comparison between blogging and microblogging gives us a good understanding of the reason behind Twitter's popularity. Blogging requires good writing skills, and large content to fill pages. Using Twitter does not require sound grammar knowledge or long thoughts on a topic and everyone finds this encouraging to post small messages. These small posts are often criticized for their meaninglessness.

A study by Pear Analytics shows that 40% Twitter posts are "pointless babbles" [11]. Some bloggers have even suggested that Twitter is not microblogging because "the idea that someone can send a 140 character twitpith or let the world know where about in some city street they are is considered to be blogging is stupid and devalues the hard work that most bloggers do everyday" [39]. This is another way of saying that Twitter is indeed connecting people. The very basic question that Twitter asked was not "what do you think or know" but was "what are you doing". User posts to this question cannot be expected to be literature pieces.

Recently, the question that Twitter asked on the main page was replaced with "Share and discover what's happening right now, anywhere in the world". This change sparked some interest about future plans of Twitter. New sentence implies a shift to being a real time information source. However, as finding useful information became very difficult because of "babbles" and spamming bots, Twitter came up with a lists feature. With this feature, users are able to group users in lists and make these lists private or public. In the public case, other users are able to add all of the users on list with a click. Simplicity is due to an early decision by Twitter to share posts with third party applications. Starting with Twiterrific in January 2007, many applications have been created [42].

Twitter applications range from finding similar users to finding answers to your questions and even writing book reviews. Many Twitter applications were written by Twitter users who saw a need for a specific use, and developed an application. As the creator of now defunct Quotably explains; "I was intrigued by just what conversations were shifting into this new space and frustrated by how difficult they were to follow. Threading seemed like to obvious solution and I set out to scratch the itch" [43]. Each application grew in some communities and contributed to Twitter's success by attracting more users. This trend has been growing so much that, according to the 2009 HubSpot report, only 48.1% of all users used web to access Twitter [8]. The report is from February 2009, and in the face of hundreds of new applications, we can only expect to see web usage increase.

4 Twitter Architecture

“Architecture originates with a disappointment in the provisional”, anonymous.

Twitter API is based on Representational State Transfer (REST) architecture. The architecture itself can be seen as a philosophy, not as a blueprint. Guiding principles of a REST interface are identification of resources that are kept on the web site and manipulation of resources through representations for users. In this way, clients, if permitted, can modify or delete data on servers [44]. REST has been applied to describe the desired Web architecture, helped to identify existing problems, to compare alternative solutions, and to ensure that protocol extensions would not violate the core constraints that make the Web successful.

From Twitter perspective, the REST architecture means that Twitter will be able to work with web syndication formats. Twitter works with two of these formats. Really Simple Syndication (RSS) and Atom Syndication Format (Atom). Visitors can subscribe to syndication service (feeds) and receives an update every time web administrator changes the page. In this sense each Twitter user has a subscription to the users he follows. Twitter’s open API decision lets third party applications read user’s feeds, and desktop and mobile phone applications on Twitter use this functionality [45].

From the beginning, Twitter search API was always the focus of criticism. For users who followed many people, finding tweets was a major issue. The search engine, Summize.com was acquired in 2008 to solve this problem. Before the acquisition, Summize.com was very popular among Twitter users, and finally the service caught Twitter’s attention. After a 15\$ million deal, Summize.com workers joined the ranks of Twitter, and the service currently serves as “Twitter search”.

In addition to Search and Rest APIs, Twitter also has a Streamline API with famous services such as BirdDog and GardenHose. Those services are mostly used by researchers who need a larger data set than regular users.

Despite all those APIs, Twitter does not yet allow searches older than a certain time period. This time limit depends on the number of posts about the search term. A vague number of latest 3200 posts, or a 1.5 week period is posed for the search limit. Many researchers turn to third party search engines in cases when they need old posts. Many popular search engines such as Twopular.com, Topsy.com and Trendistic.com fill this void.

Twitter uses OAuth and Basic Authentication for the authentication. OAuth is an open protocol to allow secure API authorization in a simple and standard method from desktop and web applications [50]. What this protocol implements is of vital importance to Twitter, because OAuth enables third party applications that are abundant on Twitter to connect to user accounts without a username and password authentication. Any application that needs to connect to a user account can be directed to a page on Twitter, and users can click on tabs to allow the application. This way, the application cannot learn your password, and “if you ever suspect an application to be doing something it shouldn’t with your Twitter account, you can simply turn off their connection without having to change your password” [51]. Although OAuth proposes a secure way to handle applications, some major security flaws prevented a full dependence on OAuth. In April 2009, after a major flaw was discovered in OAuth protocol, Twitter, as well as Yahoo,

pulled their support on OAuth [52]. Current day applications on Twitter can use either OAuth or the Basic Auth that asks users their passwords. As Twitter wiki explains “We (Twitter) would like to deprecate Basic Auth at some point to prevent security issues but no date has been set for that. We will not set a date for deprecation until several outstanding issues have been resolved” [53].

As the user base grew and scalability issues surfaced, Twitter joined Facebook and Google to use cloud computing. In March 2009, Salesforce.com announced that it put Twitter in its service cloud [46]. Shortly after, in June, a French hacker broke into a Twitter administrator’s account and this sent shock waves through the cloud computing society. The hacker not only accessed the administrator’s mails, but he also accessed his Amazon.com and PayPal accounts. Moreover, the hacker managed to download some company files about company plan, and marketing strategies. Security issues of cloud computing suddenly caught up a huge attention. Experts warned that “What it (the attack) really highlights is the extreme interconnectedness of the social Web: with the likes of e-mail contact importing and data-portability services like Facebook Connect now commonplace, a savvy hacker can have access to multiple accounts simply by accessing one” [47].

Despite those security issues, the biggest threat to Twitter’s success lies in scalability issues. Twitter is a famous Ruby-on-Rails deployment. Ruby-on-Rails is an open source web platform for the Ruby programming language. The platform was created as a protest against Java platforms, and Twitter’s scalability has often turned into a hot debate between these two platforms. To understand the debate and the issues that can lead to scalability issues, the design philosophy of Ruby-on-Rails (RoR) is worth mentioning. Ruby on Rails is intended to emphasize Convention over Configuration (CoC), and the rapid development principle of Don’t Repeat Yourself (DRY) [48]. “Convention over Configuration” means a developer only needs to specify unconventional aspects of the application. Conventional aspects are not coded. This leads to less code and less repetition.

“Don’t repeat yourself” means that information is located in a single, unambiguous place. For example, using the ActiveRecord module of Rails, the developer does not need to specify database column names in class definitions. Instead, Ruby on Rails can retrieve this information from the database based on the class name.

With the instant fame after 2007, and increase in the visitor number, Twitter had to think about scalability issues. Former Chief Architect Blaine Cook famously said scaling Rails was easy in April 2007, but the problems continued and the famous “fail whale” image that greets users whenever the site is down became a popular icon in society. Twitter still uses Ruby-on-Rails, but started using SCALA for heavy and asynchronous jobs in April 2009 [49].

5 Application Domains

5.1 Marketing

Before we have a look at Twitter’s influence on marketing, let’s start with exploring how it effects its third party applications.

Java [3] et al. reports that 13% of all posts include links. In order to overcome the character limit, Twitter had first used URL shortening application TinyUrl but switched to bit.ly. Bit.ly is a portfolio company of Betaworks, and Betaworks became an investor of Twitter after Twitter acquired another Betaworks company, Summize.com. So Twitter's decision did not come as a big surprise. The drop in the visitor count of tinyUrl.com shows that, Twitter's impact on the third party applications is not negligible.

Twitter is becoming the next-big-thing on web, and we can compare it to early giants like Google, Youtube and Facebook. What we cannot compare with is the marketing plans of those companies with the marketing plan of Twitter. Twitter critics often point out that Twitter does not have a sound marketing plan, and cannot get profitable. Only recently, Twitter's deals with Google and Bing to hinted a potential source of cash, but still it is a gold mine that is not fully utilized.

Twitter hype or Twitter's optimistic atmosphere, whatever you may call it, may solve the marketing problem. Human participation on such a marketing plan would provide some useful insights. There are already some signs; David Wilson, a horror and sci-fi author had recently asked his fans about a Twitter promotion and there is already another novel, "Sum" by David Eagleman's, that had a 6000% sales spark thanks to Twitter [56].

This sales increase is described by word of mouth marketing. Word of mouth effect is defined as passing information from people to people, and what can be more successful at it than Twitter? Twitter seems like an ideal salesperson which gives you short information of product, but does not bore you with details if you do not like the product. This aspect of social networks and word of mouth (WOM) marketing has already attracted some interest [61]. A study shows that WOM marketing has 20 times higher elasticity than traditional marketing. Here elasticity is described as the change in sales resulting from each dollar spent [58].

Companies that use Twitter as a market place include Dell, Delta airlines, Buy.com and many others. Recently many blogs have been created to teach companies on how to use Twitter as marketing platform. Those blogs see Twitter as *instant messaging amplified*. Marketing advantages on Twitter are listed as *rapidly disseminating timely information to groups that are in disparate locations or from live events, as an extension of PR efforts, personal branding, enhancing a blog or Web site by making it more real-time and more interactive, as a direct marketing promotional tool* [60].

Brand recognition is another hot issue for companies that has yet to gain a loyal customer base. Twitter can be used to create a brand awareness in public through advertising microposts.

As a direct marketing tool, Dell has used Twitter successfully, and generated \$2million in revenue by posting on Twitter [62]. For large corporations, using Twitter to get fast feedback on services and products has been very popular, and many instant posts about product reviews by customers such as *Tablet, tablet, tablet! I will be pissed if it is iPhoneOS-based. It should run MacOSX and do anything a macbook air does, only better.* can be found on Twitter [59].

5.2 News

Twitter is also regarded the fastest way to reach to breaking news. Users' collaboration has given Twitter a clear edge over news centers like cnn.com. Recently news centers have set up Twitter accounts and encouraged users to interact with these accounts in order to receive any breaking news in real time. CNN had to buy "cnnbrk" account with its 930 thousand users from the previous owner, and this marked CNN's dedication to Twitter [63]. CNN maintains 45 official Twitter accounts, with @cnnbrk having more than 2,7 million followers and 5 million followers in total. CNN's Twitter account has been a hot topic because Ashton Kutcher had challenged CNN to Twitter popularity contest. Eventually Ashton Kutcher reached 1 million mark before CNN [21].

Personal branding is widely used on Twitter, and Kutcher case was a prime example of this. For celebrity news, Twitter has been a bridge between celebrities and fans. Not only Ashton Kutcher, but many celebrities, including Britney Spears, Oprah Winfrey and even Barack Obama have started to use Twitter, and especially Oprah Winfrey's Twitter debut marked a point in Twitter history as the traffic on the site jumped 43% [64].

During the election protests in Iran, Twitter played a greater role than news centers, and attracted more attention. In recent Mumbai attacks in India, just minutes after the attacks, Twitter was the major source until news sites caught up with updates [22]. Twitter's success to create a bridge between the world and the people who want to reach this world is not only thanks to microblogging posts. As well as posts, information flow to Twitter consists of pictures, links and videos.

Demonstration pictures from Iran such as [23] and the first picture from US Airways plane in the Hudson river [24] increased Twitter's popularity in the public. The Economist called Twitter a winner in this information race [25]. During Iran elections, this information stream also caught the attention of US and Iran governments. US government reportedly warned site owners not to undergo a maintenance for it would break the news stream from Iranian users [57]. Even after banning foreign journalists from covering rallies, Iran could not stop information flow and finally shut down access to Twitter.

As Twitter was used by more people, its popularity increased. The trend of using Twitter for fast information revealed itself when an American student was arrested in Egypt for taking photos. The student was able to post a tweet saying "Arrested". His friends reported his arrest to authorities, and American embassy in Egypt secured his release [26]. Such sporadic news trends helped Twitter gain a prominent role in news reporting .

As Twitter's role in news reporting increased, so did the possibility of its misuse. A tweet post about controversial California gay marriages issue caused a big buzz in Twitter community. The post informed that California Supreme Court had overturned Proposition 8, the voter-approved ban on gay marriage [27]. This false news post created an awareness about news reporting on Twitter. Users are eager to follow breaking news on Twitter, yet they question reliability of the news until it appears on big news centers.

Recently some big media outlets are incorporating Twitter based news into their sites. Users are given an option to turn off automatic one minute updates on a web page that gets content from Twitter. The content includes pictures, videos and posts which are

approved for their credibility before being added to the page [28]. Such applications should be carefully observed, because they have the potential to overthrow current day static paged news reporting techniques.

5.3 Education

Sharing information in microblogging and emergence of vastly popular web sites pushed mobile education into microblogging domain. A paper by Ebner et al. examines the user behavior and asks the question “Microblogging-more than fun?” [29]. As the paper explains, distant education, or E-learn platforms had previously been defined with rigid terms. Accessibility to learning material was only possible on some defined computers and domains. The next push towards E-learn comes with mobility.

Mobility, in this sense, *should not be restricted to accessibility from home, university or a defined place* [29]. Microblogging gives the users tools necessary to coordinate and simulate a learning experience. As successful websites emerge, users and teachers will have a robust infrastructure to enhance their education experience. Ebner describes the success of weblogs in education based on three factors: usability, collaboration and personality. Usability makes it easy to blog, collaboration makes it fun and personality brings the dedication of user. Microblogging nicely fits into this scheme too. Microblogging enables a real-time interaction between users, and it has been used to simulate a class atmosphere between students that use different applications. Ebner et al. concludes that, *Microblogging does not bring the potential to write articles, but it can be used effectively to connect each other and to inform about interesting things about e-learning.*

In a case study, Holotescu et al. [41] have set up Cirip.ro, a microblogging site, to simulate a class. They found microblogging to *be an effective tool for professional development and for collaboration with students and also provide valuable interactions in educational context.*

5.4 Crowdsourcing

Twitter has a huge potential for crowdsourcing. Crowdsourcing is “a neologism for the act of taking tasks traditionally performed by an employee or contractor, and outsourcing it to an undefined, generally large group of people or community in the form of an open call” [33]. Optimism about the future of crowdsourcing runs very high, even to the point that, Laura Fitton, a social media blogger says “I outsource my entire life. I can solve any problem on Twitter in six minutes” [34].

With crowdsourcing on Twitter, users are able to find resources very fast. Examples of crowdsourcing range from reporter’s asking users about story ideas [35], minutiae of tax form fillings [36] or many other things [37]. Some applications [55] have already started utilizing crowdsourcing, and it seems to be a dynamic field. Another kind of usage is scholarly crowdsourcing. Although not fully utilized yet, some experiments show signs of future use [38].

Recently, Google joined this wave by buying a Twitter crowdsourcing tool, Aardvark[55].

5.5 Enterprise Microblogging

For an enterprise, that has many offices in different regions, microblogging can be used to heighten awareness in the enterprise. Gutwin et al. distinguishes four types of awareness; informal, social, group-structural and workspace [40].

Current day technologies, such as mails or bulletin boards are used to heighten group-structural and workspace awareness, but interaction is very limited in these forms and they fail to heighten the other types of awareness. As microblogging enables user interaction, it can be very effective to heighten all these forms of awareness. On the other hand, using a public microblogging site like Twitter poses great problems, because enterprise communication can reveal important strategies and long term goals, also Twitter is not very reliable and can cause disruptions in data communication when it is down.

In a case study, Bohringer et al. developed and tested a microblogging software without promotion among employees [15]. The results show that, entreblogging can create a *single point of truth* where all employees can contribute to a discussion and learn the goals ultimately. The study found that even the employees who do not contribute greatly to the discussion can be aware of all interactions within the microblogging site. This creates an awareness about the goals of the enterprise.

5.6 Alert Systems

The biggest disadvantage of current day alert systems is that, public cannot be alerted if public are not reading their mails or text messages. In the case of Fort Collins emergency system facing a tornado, residents could not get any warning emails or text messages even if they read their messages, because the system failed even before the tornado was going to hit the city [30].

Another issue for cities is the cost that is associated with sending mails or sms messages. Twitter brings up a full-fledged system that can connect residents of a city with virtually no cost. It also increases the abilities of an alert system by inputting more user generated data. Some cities already opted for Twitter to alert their residents [31]. The Virginia Tech incident in 2007 highlighted the security issues on university campuses. In the incident, the university tried every channel it could to alert students. With mobile Twitter applications that students can connect to an alert account, Twitter offers a unique service with again virtually no cost. Pacific university has already implemented a Twitter based alert system for its students, and the trend is likely to grow [32].

As with all good things, an alert system on Twitter has some drawbacks. The most notable one is the fact that Twitter is serving on an “as is” basis. Virtually it cannot guarantee a fully functioning service. It has maintenance periods which mean a big gap of time in the face of an emergency, and worse than that, it can get overloaded pretty often. A fail-whale image will not help people when a tornado is about to hit the city. Of course people can continue using a reliable alert system from other companies if functionality is a big concern. But with its entire popularity, user base and zero cost, Twitter can push proprietary alert systems out of business. Once Twitter replaces those alert systems, it will be a single point of failure which the public cannot afford to lose. Already, TechRadium, a Texas based company that produces alert systems sued Twitter for patent infringement in “mass notification” concept.

6 Third Party Applications of Twitter

“The difference was at least as old as the digital computer. Forgers created a new technology and then moved on to the next project, having explored only the outlines of its potential. Honers got less respect because they appeared to sit still technologically, playing around with systems that were no longer start. Hacking them for all they were worth, getting them to do things the forgers had never envisioned”. p76, The Diamond Age, Neal Stephenson.

While a very broad classification can be made on the PC/mobile phone application basis, Twitter applications are too diverse to fall into two categories. Some applications have both PC and mobile phone support, but in general, PC applications offer more variety. Hundreds of applications are available on Twitter and everyday some others pop up. Application rankings change overnight, but to get a glimpse of what would be a classification of them, some of most popular applications [54] and some others are classified into nine categories here:

1. Location : Those applications use maps to show status posts. They can be configured to show posts only from certain regions.

*Twittervision*¹⁷, *Twittearth*, *TwitterAtlas*, *Twibs*²⁰.

2. Similarity :Applications that give user information, find similar people. Some applications use bios to group similar people, and user posts can be scanned to find people with same hobbies, background and profession.

*TwitterCounter*⁴, *Twitterholic*⁶, *Twubble*, *Twittieme*, *Twellow*, *Twitrunk*.

3. Search&Monitor :Applications that search and monitor patterns on media. These applications are more oriented toward scanning posts instantaneously and more interested in posts than people.

*Twitturly*⁸, *Tweetscan*¹⁴, *Tweetburner*¹⁵, *Monitter*¹⁹, *Twistori*²¹, *Hashtags*.

4. Processing :Applications that enable threading a conversation/media sharing process. These applications solve the problem of losing track of a conversation. Users can see post exchanges between other users.

Tweet2tweet, *Tweepler*¹¹.

5. Sharing :Applications that enable sharing media, other than micro blogging posts. Examples include feeding your blog post excerpts to Twitter, picture sharing and even preparing polls on Twitter.

*Twitpic*¹, *Twitterfeed*⁵, *Twtpoll*, *Twitdom*¹³.

6. Enhancers :Applications that enhance personal pages, or your posts. These range from giving you special characters to use in your post to filtering out all Twitter traffic for some time.

Twitter Keys, *Twalala*.

7. Platform :Applications that connect multiple platforms. With these, users can change their status fields on many sites at once. With Hello.txt, user can change Facebook and Twitter status posts at once.

Hellotxt¹², *Digsby*³.

8. Access :Applications that provide access to Twitter. Those can be from mobile phones or browser extensions. Although they can also share data, their primary goal is to connect you to Twitter.

Tweetdeck², *Twitbin*²².

9. Hybrid applications :Applications that utilize more than one feature. Many applications use more than one feature, but our definition for hybrid states that, an application should integrate two services to perform a task. As Twitter grows, we will be able to see more mash-ups with other technologies.

Twitterfall(Location, Similarity).

As a precaution, these categories should always be considered dynamic. Some applications can merge more features in future, and even some of them can migrate to another category. Given Twitter's dynamism, a classification will be tenuous and time-dependent at best. We welcome suggestions about our classification.

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