

Data Mining Emotion in Social Network Communication: Gender differences in MySpace

Mike Thelwall, David Wilkinson, Sukhvinder Uppal
Statistical Cybermetrics Research Group, School of Computing and
Information Technology, University of Wolverhampton, Wulfruna Street,
Wolverhampton WV1 1SB, UK.

E-mail: m.thelwall@wlv.ac.uk, d.wilkinson@wlv.ac.uk, s

Tel: +44 1902 321470 Fax: +44 1902 321478

Despite the rapid growth in social network sites and in data mining for emotion (sentiment analysis), little research has tied the two together and none has had social science goals. This article examines the extent to which emotion is present in MySpace comments, using a combination of data mining and content analysis, and exploring age and gender. A random sample of 819 public comments to or from U.S. users was manually classified for strength of positive and negative emotion. Two thirds of the comments expressed positive emotion but a minority (20%) contained negative emotion, confirming that MySpace is an extraordinarily emotion-rich environment. Females are likely to give and receive more positive comments than males, but there is no difference for negative comments. It is thus possible that females are more successful social network site users partly because of their greater ability to textually harness positive affect.

Introduction

The computer-aided detection, analysis and application of emotion, particularly in text, has been a growth area in recent years (Pang & Lee, 2008). Almost all of this research has focused on detecting opinions in large bodies of text. For example, a program might scan a large number of customer comments or reviews of a manufacturer's products and report which aspects of which products tended to receive positive and negative feedback. Known as opinion mining (computer science) or sentiment analysis (computational linguistics), this approach typically works by identifying positive words or phrases in free text (e.g., "I like", or "rocked!") and tying them to the objects referred to (e.g., "the leather seats", "the package of extras"). From a wider social perspective, emotion is important to human communication and life and so it seems that the time is

ripe to exploit advances and intuitions from opinion mining in order to detect emotion in a wider variety of contexts and for primarily social rather than commercial goals. In particular, is it now possible to detect emotion in people's textual communications and use this to gain deeper insights into issues for which emotion can play a role? For instance, how important is emotional expression for: effective communication between friends or acquaintances, winning an online argument, automatically detecting abusive communication patterns in chatrooms, or detecting predatory behaviour online?

This article begins the process of moving from opinion mining to emotion detection by using a case study of MySpace comments to demonstrate that it is possible to extract emotion-bearing comments on a large scale, to gain preliminary results about the social role of emotion and to identify key problems for the task of identifying emotion in informal textual communications online. Hence, although it is preliminary and exploratory it is designed to report useful information for future emotion detection research and for those interested in social network communication. Large scale data collection and analysis from social network sites has already been used for social science research goals (Kleinberg, 2008) but not yet in combination with emotion detection.

Background

This section reviews several aspects of the background to automatic emotion detection in social network sites: opinion mining (i.e. automatic opinion detection); the psychology and sociology of emotion (because emotion is a complex construct); and social network communication and usage. Gender differences in emotion and language are also discussed.

Opinion Mining and Text Mining

Opinion mining or sentiment analysis is the automatic detection of opinions from free text. This research area has been partly motivated by the commercial goal of giving cheap, detailed and timely customer feedback to businesses (Pang & Lee, 2008). Before the Internet, businesses would have to rely upon relatively slow and expensive methods of gaining customer feedback, such as phone or mail surveys, interviews and focus groups. Online, however, they may be able to gain feedback from online customer reviews, blogs, comments and chatroom discussion, assuming that a computer program can filter out the relevant data from the rest of the web or a particular reviews website. In this context, the goal of opinion mining is to identify positive and negative opinions in free text and to associate this

opinion with relevant objects. The goal might be detail in the sense of identifying what is discussed and how (e.g., which aspects of a car are liked or disliked), or the goal might be a judgement in the sense of diagnosing the nature and strength of opinion (e.g., diagnosing how much a reviewer liked a film from their online review).

Opinion mining is often split into two consecutive tasks: detecting which text segments (e.g., sentences) contain opinions and the polarity and perhaps strength of that opinion (Pang & Lee, 2008). A simple technique counts how often positive and negative words occur or how often they co-occur in sentences with given target terms (e.g., “engine reliability”). Whilst full machine comprehension of text is currently impossible, computational linguistics techniques can partly analyse the structure of text, using it to more accurately detect sentiment. This approach might incorporate negating words (Das & Chen, 2001) like “not”, booster words like “very” and grammatical structures common in sentiment-bearing sentences (Turney, 2002). It relies upon reasonably grammatically correct English to function effectively, however, which makes it less useful in environments like social network sites with much informal language. Many refinements of the above approaches have been proposed (e.g., Konig & Brill, 2006; Turney, 2002). Text mining applications have also been developed in psychology, communication studies, management and corpus linguistics (for a review see: Pennebaker, Mehl, & Niederhoffer, 2003). For instance, some psychological disorders can be quite reliably diagnosed in patients based upon a simple word frequency analysis of speech (Oxman, Rosenberg, & Tucker, 1982); political statements (Hart, 2001) and business mission statements (Short & Palmer, 2008) have been analysed for the strength of variables including optimism; and a factor analysis across a wide range of text genres has identified that the degree of author involvement in a text as opposed to an informational orientation (arguably a weak expression of emotion) is something that tends to be constant within genres but varies between genres (Biber, 2003).

The psychology of emotion

Many different aspects of emotion can be measured, including: individuals’ self-reports of feelings, neurological changes, autonomic system reactions, and bodily actions – including facial movements (Mauss & Robinson, 2009). These seem to overlap to between different emotions leading them to be described as syndromes rather than clear sets of identifiable features. Eckman (1992) and others nevertheless argue that there are basic or fundamental emotions that are relatively universally recognised and

apparently experienced by humans, and that these exist as a result of evolutionary pressure. For example, autonomic changes and cognitive processes during fear prepare a person to run away from danger. In support of this, there is scientific evidence that at least five different emotions (fear, disgust, anger, happiness, sadness) are demonstrably different in the sense of activating different combinations of brain regions (Murphy, Nimmo-Smith, & Lawrence, 2003); adding surprise gives Ekman's (1992) main list of six basic emotions. Ekman's (1992) evidence found in support of emotions being basic is a set of six general characteristics common to all basic emotions (e.g., brief duration, presence in other primates) and three types of characteristic that exist but differ between emotions: signals (e.g., facial expressions); physiology (e.g., autonomic nervous system activity patterns); and antecedent events (e.g., a dangerous event occurring).

The above list excludes some emotions considered important by others, such as anxiety, guilt, shame, envy, jealousy, compassion and love (Lazarus, 1991, p. 122). Non-basic emotions are sometimes seen as combinations of basic emotions and seem to vary more between cultures. Emotion perception is culture-specific because some societies describe emotions never apparently experienced elsewhere (e.g., the oft-mentioned "state of being a wild pig" (Newman, 1964) in a New Guinea community).

From the perspective of felt human experiences rather than at the neurological or descriptive levels, it seems that there are *two* fundamental dimensions rather than a range of differing kinds of emotions (Fox, 2008, p. 120). First, the *valence* of an experienced emotion is the degree to which it is strongly positive or negative. Second, the level of *arousal* felt is the amount of energy perceived (e.g., from lethargic to hyperactive). This assertion apparently contradicts the neurological evidence above of at least five emotions and the linguistic evidence in the form of the existence of a wide range of non-synonymous terms for emotions. Nevertheless, research has shown that people describing the same traumatic event may use a wide range of different emotional terms (e.g., sad, angry, upset) almost indiscriminately (Barrett, 2006) and that the two dimensions of valence and arousal seem to be the key underlying factors. A consequence of this is that identifying valence and arousal is likely to be far easier and more reliable than other types of emotion detection.

Almost contracting the valence-arousal model of emotion perception, there is evidence that levels of positive and negative emotion are not correlated: a person can simultaneously experience varying levels of both, although they may be perceived as separate simultaneous emotions (Watson, 1988) – for example, enjoying the fear in bungee-jumping or missing a loved one.

Importantly for emotion classification in the current paper, individuals perceive and react to potentially emotional stimuli in significantly different ways. Personality differences impact the strength of emotion perceived from a stimulus and the tendency to perceive a negative or positive context when there is a choice. The latter broadly reflects a pessimistic or an optimistic person. More specifically, two of the five commonly recognised personality traits in psychology are associated with the ability to experience emotion: extraversion with positive emotions and neuroticism with negative emotions (Fox, 2008, p. 53-58). It has also been shown that people react in different ways even to clear emotion expression devices, such as emoticons, in the sense of drawing inferences about the characters of the users (Fullwood & Martino, 2007). In consequence, irrespective of life experiences, people with different personalities are likely to disagree about the strength and polarity of emotion in many situations.

The sociology of emotion

In addition to psychological research and the social psychological perspective of identifying social and cultural factors in emotion expression, emotion has been extensively studied in sociology. Many theories have been developed to explain the role of emotion in various situations. One review grouped these theories mainly into the following broad types: dramaturgical and cultural, regarding emotion as a performance by individuals to an audience; ritual, regarding emotion as an important outcome of ritual processes, not only religious ceremonies but also standardised procedures used in human interaction; symbolic interactionist, regarding emotions as sometimes generated when individuals' self-identities are threatened or reinforced; symbolic interactionist with a psychoanalytic focus, analysing strategies used to deal with lack of confirmation of identity; exchange theories, regarding emotions either as commodities to be exchanged or as the outcome of exchanges; structural theories, based upon social power structures; and evolutionary theories, explaining current emotions on the basis of evolutionary social pressures (Turner & Stets, 2005, p. 23-25). Additional groups of theories have also been proposed (Stets & Turner, 2007).

All of the above theories could add something to the understanding of emotion in communication between pairs of friends in social network sites, but they are mostly of peripheral relevance. For example, they typically involve groups of people rather than individuals or dyads. Whilst several theories are particularly promising on the surface, ritual theories tend to emphasise aspects of face-to-face communication, or co-presence, that are

irrelevant here; dramaturgical theories are “best applied to situations where group solidarity is built up”; exchange theories tend to focus on emotion as the outcome of exchanges or networks of relationships (Turner & Stets, 2005, p. 99). Nevertheless, the approaches and ideas introduced in the emotion of sociology are important to emphasise that the expression of emotion is not just a simple description of a person’s internal emotions but may be used by them in ways that are influenced by the people around them, their strategic goals, and previous experiences.

Gender and emotion

There seems to be a widespread belief, at least in Western societies, that women are “the emotional sex” and that men are emotionally inexpressive (Shields, 2002, p. 122; Zammuner, 2000), although this belief may be decreasing (Timmers, Fischer, & Manstead, 2003). In response, research has confirmed a tendency for women to report feeling stronger and longer emotions and to express them more clearly, except perhaps for anger. These findings cover a wide range of international cultures but are more marked in the West (Fischer & Manstead, 2000). This overall tendency must be qualified because differences in emotion expression vary by social context and by type of emotion. For example, women seem more likely than men to employ positive emotions in an empathetic or socially supportive contexts, known as prosocial behaviour (Hoffman, 2008) For instance prosocial behaviour includes expressing joy for another but not expressing self-pride (see also Shields, 2000).

Women also seem more ready to express (negative) emotions associated with vulnerability (Brody & Hall, 2008), possibly reflecting gender role social expectations (Shields, Garner, Di Leoni, & Hadley, 2007), whereas men seem more ready to show anger. Women see the use of positive emotion amongst friends as socially desirable in a way that men do not, even though both seem to have a similar level of understanding about appropriate contexts in which to express emotion (Stoppard & Gunn Gruchy, 1993). The increased use of positive emotion by women may relate to socialisation for its importance in childcare and other caring activities that are disproportionately performed by women (Alexander & Wood, 2000). In contrast, men’s tendency to hide their emotions in certain situations can be seen as a dysfunctional response to gender role expectations (e.g., strength, stoicism) (Jansz, 2000; Vogel, R. Wester, Heesacker, & Madon, 2003).

The above gender differences may be amplified for emotions expressed in public spaces, like SNSs, because women seem to be more ready to share

emotion in public than men (Rime, Mesquita, Philippot, & Boca, 1991)

Social network sites

Social network sites (SNSs) are web sites that allow users to register, create their own profile page containing information about themselves (real or virtual), to establish public 'Friend' connections with other members and to communicate with other members (boyd & Ellison, 2007). Communication typically takes the form of private emails, public comments written on each others' profile pages, blog or pictures, or instant messaging. SNSs like Facebook and MySpace are amongst the ten most popular web sites in the world according to Alexa (http://www.alexa.com/site/ds/top_sites, accessed January 28, 2009). SNSs are very popular in many countries, including Orkut (Brazil), Cyworld (Korea), and Mixi (Japan).

SNS growth seems to have been driven by youth, with MySpace having an average age of 21 for members in early 2008 (Thelwall, 2008) and Facebook originating as a college site (boyd & Ellison, 2007). Nevertheless, it seems that an increasing proportion of members are older. A key factor motivating SNS use seems to be sociability, however, suggesting that some types of people may never use social network sites extensively (Tufekci, 2008b). Moreover, it seems that extraversion is beneficial in SNSs (Sheldon, 2008) and that female MySpace users seem to be more extraverted and more willing to self-disclose than male users (Schrock, 2009), which hints that they may be more effective communicators in this environment.

One interesting aspect of SNSs is that they support relatively public conversations between friends and acquaintances. SNS profiles are known as venues for identity expression of members (boyd, 2008; boyd & Heer, 2006; Walther, Van der Heide, Kim, Westerman, & Tong, 2008) and since public comments appear in these profiles, they may also be composed or interpreted from the perspective of identity expression rather than performing a pure communicative function. From a social sciences perspective the public conversations are interesting because the web now contains millions of informal public messages that researchers can access and analyse. Moreover, demographic information about the sender and recipient are also often available in their profile pages. An ethical issue potentially arises with this kind of data because its owners have not explicitly given permission for its use in research (unlike standard interview or questionnaire protocols). However, if the data has been placed in the most public place online (findable by Google) then its use does not constitute any kind of invasion of privacy (e.g., see the distinction between

natural and protected privacy in Moor, 2004). An ethical issue only arises if feedback is given to the text authors or if contact is established.

Some data mining research has analysed MySpace, but for commercially-oriented rather than social science goals: an IBM study demonstrated how to generate rankings of musicians based upon opinions mined from MySpace comments (Grace et al., 2007) and a Microsoft team developed a league table system for movies by extracting lists from MySpace profiles, without explicit sentiment analysis (Shani, Chickering, & Meek, 2008).

Gender and language use

Gender variations in language use are relevant to the research questions in this paper, especially when they relate to emotion expression. Two key factors that are known to vary by gender are affiliative and assertive language use. Affiliative language affirms or positively engages the other person, for example by showing support or expressing agreement. In contrast, assertive language includes directive statements and criticism.

Women tend to use affiliative language more and men tend to use assertive language more (Graddol & Swann, 1989; Leaper & Ayres, 2007; Leaper & Smith, 2004). This is in broad agreement with other research that suggests that “women more often focus on the

social or affective function of talk, while men tend to orientate to its referential function” (Holmes, 1995, p. 30). In order to partially explain findings like these, Maltz and Borker (1982) have suggested that girls learn to use language to create and maintain closeness with others through supportive and inclusive forms of speech. In contrast, boys learn to use words to assert dominance through commands and challenging statements. Of the two categories, affiliative language seems most likely to contain positive emotions and assertive language seems most likely to contain negative emotions.

Some psychology theories also claim that girls have, in general, a slight advantage in language development over boys because of evolutionary pressures leading to differing brain organization and functioning (Andersen, 2006) and hence women may simply perform better in some communication environments. It seems possible that increased affective style could be part of this improved performance.

In terms of different forms of computer-mediated communication, it seems that offline patterns of emotion use are similar to online patterns in a variety of environments (Derks, Fischer, & Bos, 2008). Of particular relevance for the research in the current paper, women only discussion groups seemed to involve more emotion-related communication, with male-

only groups using less, with the latter groups apparently suffering as a result (Savicki & Kelley, 2000; Victor Savicki, Lingenfelter, & Kelley, 1996). Another study of internet discussion groups found women to conform to offline patterns of relatively high levels of supportive positive communication, although men were more likely to post negative comments (Guiller & Durndella, 2007). Research for blogs has given different results, however, with similarity rather than gender difference being the norm (Herring & Paolillo, 2006; Huffaker & Calvert, 2005), and with teenage males using more emoticons than females (Huffaker & Calvert, 2005). As a result, whilst the default assumption for a study of any new form of computer-mediated communication, such as social network site comments, should be that gender differences can occur, this should not be assumed.

Research Questions

Following the literature review, this research takes the perspective that there are gender differences in the expression of emotion and that these are context-dependant and vary to some extent across cultures. Offline, and especially in Western societies, women tend to express positive emotion more readily than men and probably also negative emotions with the exception of anger. These characteristics are likely to transfer to some but not all forms of computer-mediated communication and so it is reasonable to investigate whether they transfer to comments in social network sites like MySpace. This study does not assume that the emotions expressed by commenters reflect their feelings or invoke the surface emotions in readers. In contrast it seems that such emotions may be selected for their social role, for example as part of a performance, informal ritual or exchange. In terms of the types of emotion measured, this research focuses on valence (positive or negative) and strength rather than more specific types of emotion because this has theoretical justification (see above), is simpler and hence appropriate for initial research, and fits with exploratory analyses of the data.

The two objectives of this research are to establish that it is possible to extract emotion-bearing text from the web in a context other than opinion mining, and to identify key issues for emotion detection in this context. As part of this, the specific research questions address the role of gender and age in emotion within social network public comments, using MySpace. How common are positive and negative emotions in social network comments?

Are there gender and age differences in the extent to which emotions are expressed in public MySpace comments?

Data

The first stage was to gather a large random sample of MySpace comments. For consistency, the data gathering method was designed to get comments to or from active, normal, long-term U.S. members.

The profiles of a systematic sample of 30,000 members who joined on July 17, 2007 were automatically downloaded by selection of their numerical member ID. This data set is reused from a previous study (Thelwall, 2008) to minimise load on the MySpace web servers, but all subsequent processing is unique to the current investigation. From this set, members who had a public profile, were normal members (not musicians, comedians or movie makers) and who registered a U.S. location were selected. During November and December 2008 the MySpaces of these members were visited and all comments made to them were recorded. In addition, for each selected member a commenting friend with a public, normal profile was selected at random and all their comments recorded. The comments were then filtered for standard picture comments (e.g., MySpace Glitter Graphics comments), spam and chain messages using a set of regular expressions, removing about half of the comments made. One comment in each dialog was then extracted at random from each of the pairs. The resulting comments formed the raw data for this study and a selection of 1,000 was randomly extracted for classification, with an additional set selected for a pilot study.

MySpace comments can include HTML code and so some comments contained pictures, videos, or altered fonts. All of these elements were removed before classification, retaining only the plain text content.

Classification

A classification scheme was constructed to quantify the extent to which positive and negative emotions were expressed in each comment. A Likert scheme was used, as described in Table 4 of the Appendix. A pilot study was used to identify the issues involved in classification and to develop the class descriptors. The pilot study also revealed some common phrases that were difficult to classify. In particular, “I miss you” could be interpreted as positive and almost a synonym of “I love you”, even though it suggested sadness. Similarly, “I love you” or “love you” is ostensibly a very strong positive emotion but seems to be used relatively casually in MySpace. As a result of issues like these, a set of classification guidelines was constructed in the form of a list of phrases and associated suggested classifications (see Appendix, Table 5). The scheme was not based on previous schemes

because MySpace comments seemed to use language in a distinctive way. The final scheme was based on an extensive period of experimentation and pilot testing with different schemes, including some that combined positive and negative emotion. The positive emotion section also included expressions of energy that were not associated with an explicitly negative emotion, as these appeared to be implicitly positive in a MySpace context (e.g., “hello!!!”). Note that the classification process only deals with the text of an individual comment and is an attempt to identify the emotion expressed in it rather than the emotional state of the commenter or commentee. Also, it does not take into account the context of the comment, such as the previous comment. The reason for these choices is to simplify the process as much as possible, leaving future studies to produce more nuanced categories. Future research is needed to formally test different classification schemes, for example in terms of matching the emotion of the commenter (which is not an objective here).

The main classifier coded 1,000 comments and a second classifier coded a subset of 500 comments in order to cross-check the reliability of the results. Some of the sample were manually identified as Spam or non-English and were removed, resulting in an 18% smaller final sample size. The classifiers had no access to age or gender information during the classifications but indicators of these were present in some of the comments. The results were tested for inter-coder reliability and analysed using ANOVA.

Results and discussion

Classifier agreement

The emotion classification results were compared between coders using Cohen’s kappa reliability measure (Neuendorf, 2002). The classifiers had a “moderate” degree of agreement: kappa=0.56 for negative and kappa=0.47 for positive emotion ratings (Landis & Koch, 1977). Cohen’s kappa measures the extent to which the exact classifications are higher than that which would be predicted by chance. A figure above 0.8 could be taken to mean that the measurements were the same, but with normal human errors. The lower values here suggest that the classifiers are measuring a different but related quantity. Note that the figures do not take into account close values, such as 2 instead of 3, and so are perhaps underestimates of the extent of agreement.

A qualitative assessment of the differences in the findings suggested the following.

Classifier judgements depended partly upon the perceived *context* of the

text. For example, “I miss you too!!! Come see me soon!”, was interpreted as containing fairly strong and positive implicit emotion by one classifier but as being without positive emotion by another. One of the biggest differences was for the comment (presented slightly modified here): “the girl in the picture is my OTHER 1/2. she completes me”, which does not explicitly express emotion but is nevertheless an emotionally very warm and positive statement.

Classifiers differed on which words could be regarded as intrinsically positive or negative. For example, only one regarded the word “confused” as negative. In addition, only one regarded the following comment as negative (presented slightly modified here): “toni what da hek!!! why u up so late”.

A person’s perception of what is positive or negative depends upon factors such as their life experience, personality and taste and so differences in results are not surprising. To give an extreme example, one person might regard bungee jumping as the ultimate thrill and hence classify a comment about it as strongly positive, whereas another might be frightened of heights and classify the same comment as strongly negative – at least in the absence of additional contextual information about whether the commenter enjoyed the experience. A higher degree of inter-coder consistency could presumably have been reached if the coders were requested to focus on the words used and not to classify emotion that was not explicitly expressed, but this would have reduced external validity for the research questions. Whilst the measurement of emotion with any instrument is problematic (Mauss & Robinson, 2009) and human perception is inherently variable (Fox, 2008, p. 53-58) the differences mentioned above suggest that the classification of emotion from short comments is intrinsically difficult and often without a clear correct answer. Hence the results for the overall occurrence of emotion and gender differences are subjective and cannot give definitive answers to the research questions, particularly the first. Nevertheless, if the results are not significantly affected by the differences between classifiers then this suggests that similar findings are likely for alternative conceptualisations of emotion.

Occurrence of emotion

Table 1 illustrates the percentage of comments with each level of emotion, according to each of the classifiers. There was agreement between the classifiers that at least two thirds of the comments contained positive emotion, but less agreement about the percentage that contained negative emotion, with the second classifier finding negative emotions in 37.5% of

comments.

Table 1. Percentage of 819 public comments (main coder) and 387 comments (secondary coder) of normal US MySpace members that were judged to express various strengths of emotion.

Emotion strength	Positive (main)	Negative (main)	Positive (second)	Negative (second)
1	34.0%	80.1%	27.1%	62.5%
2	27.8%	5.6%	38.2%	22.5%
3	35.0%	10.9%	29.2%	9.8%
4	3.2%	2.2%	3.6%	4.4%
5	0.0%	0.6%	1.0%	0.0%

Age and gender factors

The results are analysed here for the main classifier and the differences between categories are consistent with the data from the second classifier. A two-way Anova analysis of these results was conducted based on the gender of the commenter and the gender of the commentee. This found that females send ($p=0.000$) and receive ($p=0.000$) comments with significantly more positive emotion than men but that there is not a significant gender difference for negative emotion in comments. There was no evidence of interaction between the gender of the comment sender and receiver for positive emotion. In particular, despite many “I love you” comments, cross-gender comments were not significantly more positive than expected from the general pattern and male-male comments were not noticeably reserved, although they may have expressed emotion in less intimate ways. Table 2 suggests that the most common source of negative comments is in male-to-male interaction, but this difference is not significant ($p=0.314$ for an interaction effect).

Table 2. Average positive (+) and negative (-) emotion in 819 U.S. MySpace public comments.

	From female	From male
To female	2.41 (+) 1.32 (-)	1.98 (+) 1.31 (-)
To male	2.22 (+) 1.32 (-)	1.67 (+) 1.50 (-)

A Spearman correlation found a small but significant (at the $p=0.01$ level) correlation between positive comment strength and both commenter age

(0.189) and commentee age (0.200). This surprising finding may be due to older members engaging in loving communication with younger relatives online (e.g., “Hi mom!!! [...] We miss you and love you!!! [...]”, “oh i love u aunt [...]”).

Table 3 reproduces three strength 3 comments for each of the four gender pairs. There is an apparent tendency for male-female interactions to be slightly flirtatious, for female-female interactions to be transparently supportive and for male-male interactions to be neither of these. There were a few messages indicative of a romantic relationship but these were rare – presumably partners would tend not to use public messaging for intimate exchanges. These observations would need more systematic analysis to confirm, though, and would be quite difficult to formally characterise with a content analysis.

Table 3. Examples of strength 3 comments.

	From female	From male
To female	[...] im so in love with you...hehe...[...] WE MISS YOU GUYS TOO! SMOOCHES!! [...] Happy Thanksgiving Love ya!	[...] lets hangout today call me girly xoxoox Hey thanks for the add beautiful. [...] [...] Stoppin by to show some love!
To male	WAT CHU MEAN.LOL [...]... so sexy! ;o) [...] You rock babe!	happy b-day dude. [...] thakx and i love it =) what's up man...good to hear from ya [...]

Limitations

This study has several limits for generalisation. It covers only one SNS and patterns of use in others are likely to be different. Similarly, members from other countries or starting times may have different patterns of use. It would therefore be interesting to see comparative studies in other contexts, especially if the results were different.

Another important issue is to investigate the extent to which the emotion in the classification scheme matches that intended by the sender or perceived by the recipient and other Friends viewing the profile. Ultimately, these would be the final arbiters of the intended or perceived emotional content of the messages, but it would not be practical and possibly not ethical to contact enough to get data to analyse statistically.

The random selection method has the disadvantage that it selects on the basis of commenters rather than individual comments. Whilst this stops prolific commenters from dominating the data, it probably gives too much weight to the comments of occasional and one-off users. A way round this problem would have been to have a minimum comment threshold, such as 15, below which commenters would be excluded.

The classification issue is also important. Whilst the two classifiers broadly agreed, it is probably not possible to get a high degree of agreement about the polarity and strength of emotion in MySpace comments for the psychological and social reasons discussed above and so research questions themselves are simplifications that do not have definite answers. The results here can therefore only claim to be reasonable answers to the questions rather than definitive. It would be valuable to use a range of classifiers to get more information about the extent of natural variation in the perception of emotion in MySpace comments.

Finally, the results are derived from public comments alone and it may be that comments in private profiles contain more emotion because it is more private or less emotion because more private people tend to have private profiles. Hence the situation could be different for private comments.

Moreover, the comments exchanged in private two-way MySpace messaging are likely to be different because they would presumably contain more exchanges between close personal friends and lovers.

Conclusions

The findings suggest that positive emotion is present in about two thirds of U.S. MySpace comments and that women are its nexus, in the sense of giving and receiving disproportionately many. The increased female use of positive emotion aligns with the offline research reviewed above that females tend to use positive emotion more than males (especially in prosocial contexts, which were not tested for here). It also fits with the finding for Internet discussion forums (but not blogs) that online gendered emotion patterns often reflect offline patterns. Since emotion expression and emotional reinforcement can be important in friendship, this may be a reason why both men and women prefer female MySpace friends (Thelwall, 2008), although cause-and-effect has not been shown here. This perhaps reflects the dysfunctional theory of men's emotional repression and the social effectiveness theory for women's use of positive (prosocial) emotions: women are simply more competent users of MySpace because they are better able to express positive emotion, probably mainly in a broadly supportive context.

The fact that men include positive emotion disproportionately in comments to women rather than men is not explained by the above discussion. It does not seem likely that a proportion of comments from males to females are within sexual relationships, since this was not evident in the data. Although lacking statistical evidence, the most likely explanation seems to be that the explicit expression of male-male social support, has overtones of weakness and therefore that the expression of love in particular is normally absent from informal male greeting rituals. For example, a male signing off a message to another male with “love, mike” might be seen as taboo in a heterosexual, non-family context in many Western cultures.

Negative emotion is much rarer than positive emotion and is not associated with gender. This is perhaps surprising, although may possibly be accounted for by the counteracting tendencies of male friends to insult each other and for females to express most types of negative emotion more frequently than males. Also interesting is a lack of interaction between sender and receiver gender overall, although it seems likely that emotion is expressed in different ways, for example with more mildly flirtatious comments occurring in cross-gender communication.

This study has shown that emotion is apparently the norm in social network websites and hence future research into social networking should pay particular attention to positive emotional expression and the role of gender in this. Whilst emotion is not the only important factor in friendly communication, with gift giving online (Pearson, 2007), reinforcement (Cairns, 2006) and self-disclosure (Tardy & Dindia, 2006) being others, its frequency makes it an important facet of communication and MySpace users should not be afraid of emotional statements: these are the norm. Finally, from the perspective of data mining emotion in social network sites, the results confirm that MySpace is an emotion-rich environment and therefore suitable for the development of specialist sentiment analysis techniques. In addition to commercial applications, this may ultimately gain new insights into the role of emotion in communication and perhaps be able to provide feedback to users on the appropriateness of their emotion use strategies. Both age and gender should be taken into account when interpreting the results of sentiment analysis. The differences in classifier results point to the difficulty in making accurate classifications, however, and the extensive use of non-standard grammar and spelling suggest that automatic classification will also be challenging with existing methods. Moreover, emotion ambiguity within numerous relatively simple stock phrases like “I miss you” suggest that research is needed to investigate how these should best be handled – and this research should probably involve

many human coders, all having access to context information for the common phrases classified. Practical problems for data mining emotion in social network sites include the large amount of spam in MySpace as well as image messages that resist text analysis methods and chain messages that ostensibly contain emotion but are not created by the sender.

Acknowledgement

The work was supported by a European Union grant by the 7th Framework Programme, Theme 3: Science of complex systems for socially intelligent ICT. It is part of the CyberEmotions project (contract 231323).

Appendix

Table 4. Classification guidelines given to all classifiers to guide their decisions.

	1	2	3	4	5
Expresses ostensibly positive emotion or general energy (ignore all negative)	Absence of anything positive.	Some weak positive elements or generic enthusiasm without a negative slant (e.g., hey!)	Clear positive elements of message (includes fun, happiness, optimism, positive evaluations, love)	Overwhelmingly positive or several positive elements or some emphasis of positive elements	Enthusiastically positive (e.g., I am very happy!!!!)
Expresses ostensibly negative emotion (ignore all positive)	Absence of anything negative.	Some negative elements, (e.g., casual "miss you")	Clear negative elements of message	Overwhelmingly negative or several negative elements or some emphasis of negative elements	Definitely negative (e.g., This is totally shit.)

Table 5. Examples of indicative emotion-related phrases and suggested classifications extracted from the pilot study and given to the classifiers (total: 154 positive; 142 negative).

Positive comment element	Rating	Negative comment element	Rating
hey!	2	i miss you	2
Thank you	2	im sorry	2
have a great day	2	damnitt	2
lol	3	i hate u	3
hehe	3	shithead	3
i love u	3	im hungry	3
im really excited	4	i'm fucking bored	4
BIG HUG	4	emo scum	4
you fuckin rock	4	Loser!!	4
super excited	5	DIE	5
I LOVE YOU SO MUCH!!!!	5	Fuck You	5
U R DA COOLEST MOM EVER	5	was soo sad	5

References

- Alexander, M. G., & Wood, W. (2000). Women, men and positive emotions: A social role interpretation. In A. Fischer (Ed.), *Gender and emotion: Social psychological perspectives* (pp. 189-210). Cambridge: Cambridge University Press.
- Andersen, P. A. (2006). The evolution of biological sex differences in communication. In D. J. Canary & K. Dindia (Eds.), *Sex differences and similarities in communication (2nd ed)* (pp. 117-135). Mahwah, NJ: Lawrence Erlbaum.
- Barrett, L. F. (2006). Valence as a basic building block of emotional life. *Journal of Research in Personality, 40*(1), 35-55.
- Biber, D. (2003). Variation among University spoken and written registers: A new multi-dimensional analysis. In P. Leistyna & C. F. Meyer (Eds.), *Corpus Analysis: Language Structure and Language Use* (pp. 47-70). Amsterdam: Rodopi.
- boyd, d. (2008). Why youth (heart) social network sites: The role of networked publics in teenage social life. In D. Buckingham (Ed.), *Youth,*

identity, and digital media (pp. 119-142). Cambridge, MA: MIT Press.

boyd, d., & Ellison, N. (2007). Social network sites: Definition, history, and scholarship. *Journal of Computer-Mediated Communication, 13*(1), Retrieved December 10, 2007 from: <http://jcmc.indiana.edu/vol2013/issue2001/boyd.ellison.html>.

boyd, d., & Heer, J. (2006). Profiles as conversation: Networked identity performance on Friendster. *Proceedings of the Hawai'i International Conference on System Sciences (HICSS-39, January 4-7)*, Retrieved July 3, 2007 from: <http://www.danah.org/papers/HICSS2006.pdf>.

Brody, L., & Hall, J. (2008). Gender and emotion in context. In M. Lewis, J. Haviland-Jones & L. Feldman Barrett (Eds.), *Handbook of emotions (3 ed)* (pp. 395-408). New York: The Guildford Press.

Cairns, L. (2006). Reinforcement. In O. Hargie (Ed.), *A handbook of communication skills (3rd Ed.)* (pp. 147-164). London: Routledge.

Das, S., & Chen, M. (2001). Yahoo! for Amazon: Extracting market sentiment from stock message boards. *Proceedings of the Asia Pacific Finance Association Annual Conference (APFA)*, Bangkok, Thailand, July 22-25.

Derks, D., Fischer, A. H., & Bos, A. E. R. (2008). The role of emotion in computer-mediated communication: A review. *Computers in Human Behavior, 24*(3), 766-785.

Ekman, P. (1992). An argument for basic emotions. *Cognition and Emotion, 6*(3/4), 169-200.

Fischer, A., & Manstead, A. (2000). The relation between gender and emotion in different cultures. In A. Fischer (Ed.), *Gender and emotion: Social psychological perspectives* (pp. 71-94). Cambridge: Cambridge University Press.

Fox, E. (2008). *Emotion science*. Basingstoke: Palgrave Macmillan.

Fullwood, C., & Martino, O. I. (2007). Emoticons and Impression Formation. *The Visual in Popular Culture, 19*(7), 4-14.

Grace, J., Gruhl, D., Haas, K., Nagarajan, M., Robson, C., & Sahoo, N. (2007). Artist ranking through analysis of on-line community comments. *Grace, J.; Gruhl, D.; Haas, K.; Nagarajan, M.; Robson, C.; Sahoo, N.*, Retrieved February 5, 2009 from: [http://domino.research.ibm.com/library/cyberdig.nsf/papers/E50790E50756F371154852573870068A371154852573870184/\\$File/rj371154852573810421.pdf](http://domino.research.ibm.com/library/cyberdig.nsf/papers/E50790E50756F371154852573870068A371154852573870184/$File/rj371154852573810421.pdf).

Graddol, D., & Swann, J. (1989). *Gender voices*. Oxford: Basil Blackwell.

Guiller, J., & Durndella, A. (2007). Students' linguistic behaviour in online discussion groups: Does gender matter? *Computers in Human Behavior,*

23(5), 2240-2255.

Hart, R. (2001). Redeveloping DICTION: theoretical considerations. In M. D. West (Ed.), *Theory, method, and practice in computer content analysis* (pp. 43-60). London: Ablex Publishing.

Herring, S. C., & Paolillo, J. C. (2006). Gender and genre variation in weblogs. *Journal of Sociolinguistics*, 10(4), 439-459.

Hoffman, M. (2008). Empathy and prosocial behaviour. In M. Lewis, J. Haviland-Jones & L. Feldman Barrett (Eds.), *Handbook of emotions (3 ed)* (pp. 440-455). New York: The Guildford Press.

Holmes, J. (1995). *Women, men and politeness*. New York: Longman.

Huffaker, D. A., & Calvert, S. L. (2005). Gender, identity, and language use in teenage blogs. *Journal of Computer-Mediated Communication*, 10(2), <http://jcmc.indiana.edu/vol10/issue12/huffaker.html>.

Jansz, J. (2000). Masculine identity and restrictive emotionality. In A. Fischer (Ed.), *Gender and emotion: Social psychological perspectives* (pp. 166-186). Cambridge: Cambridge University Press.

Kleinberg, J. (2008). The convergence of social and technological networks. *Communications Of The Acm*, 51(11), 66-72.

Konig, A. C., & Brill, E. (2006). Reducing the human overhead in text categorization. In: *Proceedings of the 12th ACM SIGKDD conference on knowledge discovery and data mining*, 598-603.

Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, 33(1), 159-174.

Lazarus, R. (1991). *Emotion and adaptation*. London: Oxford University Press.

Leaper, C., & Ayres, M. M. (2007). A meta-analytic review of gender variations in adults' language use: Talkativeness, affiliative speech, and assertive speech. *Personality and Social Psychology Review*, 11(4), 328-363.

Leaper, C., & Smith, T. E. (2004). A meta-analytic review of gender variations in children's language use: Talkativeness, affiliative speech, and assertive speech. *Developmental Psychology*, 40(6), 993-1027.

Maltz, D. N., & Borker, R. A. (1982). A cultural approach to male-female miscommunication. In J. J. Gumperz (Ed.), *Language and social identity* (pp. 196-216). Cambridge, UK: Cambridge.

Mauss, I. B., & Robinson, M. D. (2009). Measures of emotion: A review. *Cognition and Emotion*, 23(2), 209-237.

Moor, J. H. (2004). Towards a theory of privacy for the information age. In R. A. Spinello & H. T. Tavani (Eds.), *Readings in CyberEthics (2nd ed., pp. 407-417)*. Sudbury, MA: Jones and Bartlett.

- Murphy, F. C., Nimmo-Smith, I., & Lawrence, A. D. (2003). Functional neuroanatomy of emotions: A meta-analysis. *Cognitive, Affective, & Behavioral Neuroscience*, 3(1), 207-233.
- Neuendorf, K. (2002). *The content analysis guidebook*. London: Sage.
- Newman, P. L. (1964). 'Wild man' behavior in a New Guinea Highlands community. *American Anthropologist*, 66(1), 1-19.
- Oxman, T. E., Rosenberg, S. D., & Tucker, G. J. (1982). The language of paranoia. *American Journal of Psychology*, 139(3), 275-282.
- Pang, B., & Lee, L. (2008). Opinion mining and sentiment analysis. *Foundations and Trends in Information Retrieval*, 1(1-2), 1-135.
- Pearson, E. (2007). Digital gifts: Participation and gift exchange in LiveJournal communities. *First Monday*, 12(5), Retrieved June 5, 2008 from: http://firstmonday.org/issues/issue2012_2005/pearson/index.html.
- Pennebaker, J., Mehl, M., & Niederhoffer, K. (2003). Psychological aspects of natural language use: Our words, our selves. *Annual Review of Psychology*, 54, 547-577.
- Rime, B., Mesquita, B., Philippot, P., & Boca, S. (1991). Beyond the emotional event: Six studies on the social sharing of emotion. *Cognition and Emotion*, 5(5-6), 435-465.
- Savicki, V., & Kelley, M. (2000). Computer mediated communication: Gender and group composition. *CyberPsychology & Behavior*, 817-826.
- Schrock, A. (2009). Examining social media usage: Technology clusters and social network site membership. *First Monday*, 14(1), Retrieved February 3, 2009 from: <http://firstmonday.org/htbin/cgiwrap/bin/ojs/index.php/fm/article/viewArticle/2242/2066>.
- Shani, G., Chickering, M., & Meek, C. (2008). Mining recommendations from the web. *Proceedings of the 2008 ACM conference on Recommender systems*, 35-42.
- Sheldon, P. (2008). The relationship Between unwillingness-to-Communicate and students Facebook use. *Journal of Media Psychology: Theories, Methods, and Applications*, 20(2), 67-75.
- Shields, S. (2000). Thinking about gender, thinking about theory: Gender and emotional experience. In A. Fischer (Ed.), *Gender and emotion: Social psychological perspectives* (pp. 3-23). Cambridge: Cambridge University Press.
- Shields, S. (2002). *Speaking from the heart: Gender and the social meaning of emotion*. Cambridge: Cambridge University Press.
- Shields, S., Garner, D., Di Leoni, B., & Hadley, A. (2007). Gender and emotion. In J. E. Stets & J. H. Turner (Eds.), *Handbook of the sociology of emotions*. New York: Springer.

- Short, J. C., & Palmer, T. B. (2008). The application of DICTION to content analysis research in strategic management. *Organizational Research Methods, 11*(4), 727-752.
- Stets, J. E., & Turner, J. H. (2007). *Handbook of the sociology of emotions*. Chicago: University of Chicago Press.
- Stoppard, J. M., & Gunn Gruchy, C. D. (1993). Gender, context, and expression of positive emotion. *Personality and Social Psychology Bulletin, 19*(2), 143-150.
- Tardy, C., & Dindia, K. (2006). Self-disclosure: Strategic revelation of personal information in personal and professional relationships. In O. Hargie (Ed.), *A Handbook of Communication Skills (3rd Ed.)* (pp. 229-266). London: Routledge.
- Thelwall, M. (2008). Social networks, gender and friending: An analysis of MySpace member profiles. *Journal of the American Society for Information Science and Technology, 59*(8), 1321-1330.
- Timmers, M., Fischer, A., & Manstead, A. (2003). Ability versus vulnerability: Beliefs about men's and women's emotional behaviour. *Cognition and Emotion, 17*(1), 41-64.
- Tufekci, Z. (2008b). Grooming, gossip, Facebook and MySpace: What can we learn about these sites from those who won't assimilate? *Information, Communication & Society, 11*(4), 544-564.
- Turner, J. H., & Stets, J. E. (2005). *The sociology of emotions*. Cambridge: Cambridge University Press.
- Turney, P. D. (2002). Thumbs up or thumbs down? Semantic orientation applied to unsupervised classification of reviews. In: *Proceedings of the 40th annual meeting of the Association for Computational Linguistics (ACL), July 6-12, 2002, Philadelphia, PA*, 417-424.
- Victor Savicki, Lingenfelter, D., & Kelley, M. (1996). Gender language style and group composition in Internet discussion groups. *Journal of Computer-Mediated Communication, 2*(3), Retrieved April 25 from: <http://jcmc.indiana.edu/vol22/issue23/savicki.html>.
- Vogel, D. L., Wester, S., Heesacker, M., & Madon, S. (2003). Confirming gender stereotypes: A social role perspective. *Sex Roles, 48*(11-12), 519-528.
- Walther, J., Van der Heide, B., Kim, S., Westerman, D., & Tong, S. T. (2008). The role of friends' appearance and behavior on evaluations of individuals on Facebook: Are we known by the company we keep? *Human Communication Research, 34*, 28-49.
- Watson, D. (1988). Intraindividual and interindividual analyses of positive and negative affect: their relation to health complaints, perceived, stress,

and daily activities. *Journal of Personality and Social Psychology*, 54(6), 1020-1030.

Zammuner, V. L. (2000). Men's and women's lay theories of emotion. In A. Fischer (Ed.), *Gender and emotion: Social psychological perspectives* (pp. 48-70). Cambridge: Cambridge University Press.

This is a preprint of an article accepted for publication in the *Journal of the American Society for Information Science and Technology*, © copyright 2009 John Wiley & Sons