BeWell: A Sentiment Aggregator for Proactive Community Management

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Abstract

Granular, localized information can be unobtrusively gathered to assess public sentiment as a superior measure of policy impact. This information is already abundant and available via Online Social Media. The missing link is a rigorous, anonymized and open source artefact that gives feedback to stakeholders and constituents. To address this, BeWell, an unobtrusive, low latency multi-resolution measurement for the observation, analysis and modelling of community dynamics, is proposed. To assess communal well-being, 42 Facebook pages of a large public university in Germany are analyzed with a dictionary-based text analytics program, LIWC. We establish the baseline of emotive discourse across the sample, and detect significant campus-wide events in this proof of concept implementation, then discuss future iterations including a community dashboard and a participatory management plan.

Author Keywords

Social Computing; Text Analytics; Sentiment Analysis; Well-being; Human-computer Interaction

ACM Classification Keywords

H.1.2 User/Machine Systems J.4; Social and Behavioral Sciences

Introduction

The dividing line between offline and online communities is increasingly intertwined. Cases where physical presence was assumed to be a foremost asset are becoming less common. The clearest example is the 'brick and mortar' of the world's top universities slowly transitioning to MOOCs. Such a transition impacts innumerable processes, giving unprecedented space to innovate and improve. One area that has been quite static is measurement of institutional[1] wellness and happiness. Macro efforts are emergent [1,10], whereas institutional level measurements continue to share the same characteristics: they are externally audited, time-lagged, and require little stakeholder feedback [8].

In response to this, we propose an automated mechanism to find, analyze, and report social indicators from popularly used public Facebook pages of a large public German university, for a tool that is near to real time and sensitive to concerns of both privacy and the desire to participate in decision-making (Section "Facebook Adaptor and Data Preparation"). We use the following questions to guide the research: Can community characteristics like organizational belongingness and communal mood be established by their online social media profiles? If so, what characteristics are key to identifying these attributes?

There are several challenges in applying publically sourced data to institutional management. A technical challenge is isolating relevant information in what is usually short, informal text. We apply the text analytics package Linguistic Inquiry and Word Count (LIWC) [11]. The functionality is based on dictionaries that

assign over 7,000 word stems to 70 categories, ranging from functions (e.g. article, prepositions) to psychometrics (e.g. positive emotion, cognitive words) [11]. LIWC's results reflect each category's occurrence as a percentage of the total word count. Even though LIWC was developed for therapeutic writing, several studies have shown its proficiency with short, informal text [4,9]. As LIWC has been localized to German [12], we apply it to the BeWell prototype.

Another research area is design: how to assure privacy and participation with an unobtrusive tool to assure reliable, robust results. Expectations of participation and interactions with participatory bodies have changed in the digital age, especially amongst so-called Millennials [2,5]. The right to participate is key, as it has been found that communities with institutionalized rights to participation are happier overall [6]. However, privacy assurance is of the upmost concern, especially when dealing with emotional state assessment by an institution. Especially in political and institutional contexts, participation platforms aim for an efficient, transparent and user friendly process, and face the challenge of weighing privacy and personalized services. We see stakeholder integration as the second phase of BeWell, and will further discuss this in the section Future Work and Limitations.

Facebook Adaptor and Data Preparation

Facebook IDs are extracted via a web frontend requiring an active session to leverage the user's access token in Graph API calls. The adapter accessed the public elements of the universities Facebook pages of interest, extracting every post made to the timeline, differentiating posts based upon who made the post and the post type, over a chosen time span of four

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[1] This work uses institution and community interchangeably.

years (2010-2014). Entity data can be refreshed at any time. Data is stored in a relational database. A flow diagram is found in Figure 1.
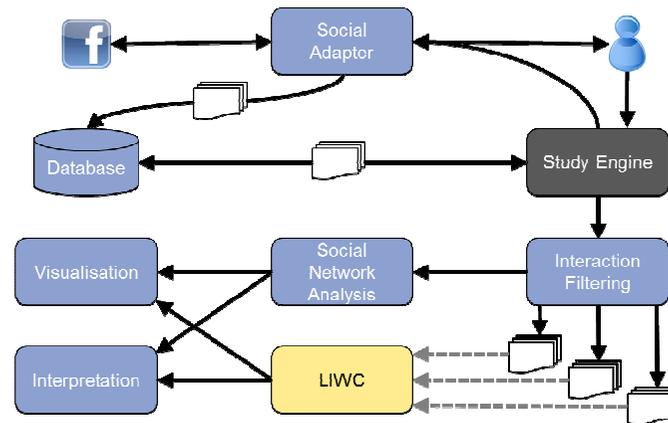

Figure 1. Workflow of BeWell

We partition the data set for LIWC based on group representations and temporal representations, rebuilding the social network weighted on an interaction basis. For most official pages only administrators permit their posts appear on the timeline, whereas constituent participation is restricted to commenting on those posts. Post-comment comparison is the logical start point for assessing communal dynamics.

Regarding group partitioning, two approaches are executed. First, all pages are assigned to one of eleven groups (see sidebar), and are then split according to their status as an administration or student-run page. Splitting the data into these subgroups aims to reproduce an accurate picture of the community, by taking interactions and communal diversities within into account.

Considering fast-paced online communities there is an interest in knowing if, and which, events have notable effects on the way the community interacts. Two points of interest are isolated for identifying changes in community activity: the semester cycles and sentiment over the year.

Establishing the Discourse Baseline

Comments show statistically significant higher LIWC scores for the categories Positive Emotion (3.52 to 2.35, $p<.001$) and Negative Emotion (0.99 to 0.42, $p<.001$) (Figure 2a). The effect is stronger for negative emotion, indicating a higher concentration of negative mood within comments. Posts eschew emotive discourse. When emotion is used, it tends to be positive. It's notable that positive scores are higher even though the LIWC dictionary allocates more words to negative emotions than to positive emotions. Amongst students emotion is expressed more freely from a 17.78% increase of the LIWC score for Negative Emotion up to a 20% rise for positive. Positive Feeling almost doubles (2.7 to 1.4) when students communicate among themselves, and affective processes rise as well (3.25 to 2.71). Comments are reactive to posts (Figure 2b). The occurrence of the
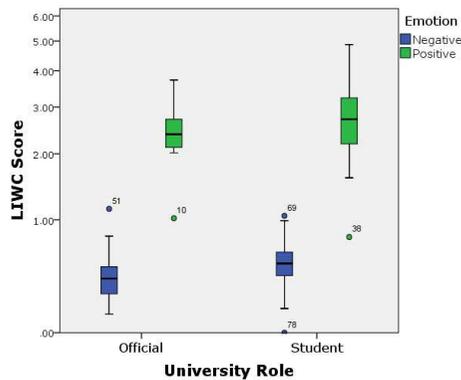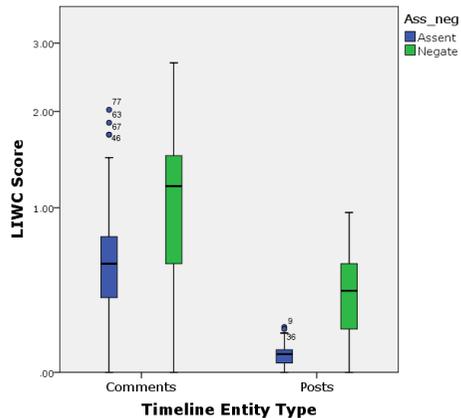
Figure 2a-b. Post-comment and administration type comparison of Facebook discourse, logarithmic scale

category Assent is over six times higher and Negations is 3.63 more frequent in comments than in posts.

Group Representations

Euclidean distance between the topics grouped as posts and comments (n=22) is performed on all LIWC categories, weighted by applying Nearest Neighbors. The absolute range is 1.69 to 15.07. First, findings of the discourse baseline are replicated at finer granularity, as the mean distance between the eleven segments is highest when comparing posts to comments (8.62). Higher similarity was found for post to post (6.92) and comment to comment (6.82) pairings. Nearest neighbors and furthest neighbors are noted in the sidebar on page 3. Paired sample t-tests found significant differences for 58% of $_{22}P_2$ possible pairings over 59 LIWC categories. Backing up the analysis with a Social Network Graph showed that sentiment analysis can imitate Network Analysis tasks, as low distance categories were situated centered and high distance topics outside in the Graph. Frequent topics have a significant impact on communal sentiment.

The second group partition aims to identify sentiment contrasts between **official pages** and **student pages**. Two reasons may lead to differing scores. It's reasonable to assume that students express themselves differently in posts compared to administration employees. In addition, students following the page could respond differently on each formality level.

Students' communication patterns show a remarkably stronger focus on Social Processes (6.58 to 4.9) and use of We (1.5 to 0.73). This is a strong signal of

communal belongingness as discussion is more formal on official pages. Increased LIWC scores from 5% to 19% for the categories concerning topics Occupation, School, and Job on administration pages support this idea. Interestingly, Family (0.36 to 0.23), Friends (0.19 to 0.16) and Humans (0.25 to 0.21) occurred more often on administration pages.

Altogether, there is indication that emotional and social discourse appears more frequently on student pages and depicts higher complexity: All of the scores indicating cognitive processes are higher (Cognitive Mechanism (4.55 to 4.21), Exclusion (1.11 to 0.96), Negation (0.58 to 0.42)). These categories indicate reflective discourse patterns.

Temporal Representations

We were able to establish a critical disappointment for students and employees as the **denial of the Elite Status** in June 2012 [3]. The loss acted as a shockwave across the various pages and was the most common discussion topic in the days after the loss, as it was expected to damage the university's prestige and also included the end of the additional 'Excellence Money,' a governmental financial support of 15 to 20 million euros yearly [3]. A 40% drop in the scores of Positive Feeling and a matching increase 33% for the category Sad are observed the week after the loss.

Regarding LIWC categories indicating cognitive complexity, a positive trend in the following three weeks of the Excellence loss compared to the overall score before June 15th exists (Table 1). Putting this together with Facebook activity almost doubling in the consecutive week, and higher scores of Past, Future, Money and Occupation is a hint for intense discussion

	LIWC Scores before Loss	LIWC Score following 3/ (1*) weeks
Article	6.68	7.64
Exclusion	0.86	1.04
Cause	0.63	0.72
Past	1.31	1.71
Future	0.56	0.71
Money	0.72	0.89* | 0.68
PosFeel	0.15	0.09* | 0.17
Sad	0.15	0.2

Table 1 Score development for comparison between all date before June 15th 2012 and the following 3 weeks after the event (1 week added if results differ considerably)
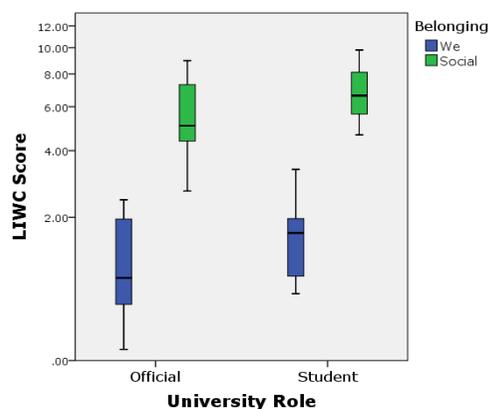

Figure 3 University role comparison of Facebook discourse, logarithmic scale

of the reasons for and future impacts of the Elite denial. It is interesting to observe that after a first distinct drop, zooming out to the following three weeks, Positive Feeling shows a slight upswing indicating communal resilience and reminding us how delicate these results are.

An interesting finding concerns expression frequency of Anger, Anxiety and Negative Emotion during exam weeks (Figures 4a-b). This is a stressful time at universities, and is reflected in Facebook chatter. Results show peaks during exams and the beginning of the semester for the category Cognitive Mechanism (Figure 4c). Interestingly, optimism is highest during exams (between 5.9% and 17.4% higher than the other intervals), which may indicate that students still handle the pressure with a positive attitude, possibly encouraging one another. Interestingly, Social Processes plateau at the middle of semester (6.7% to 11.2% higher) (Figure 4d), and decreases during holidays and exams. Information on recurring sentiment cycles is beneficial for countless purposes including increasing participation and positive feedback and encouragement.

It can be assumed that students interact online most when lectures are in session. Activity between semester intervals increases over 23% when students return to university after exams and holidays. For administrators such data can hint when a page should be most active in order to receive attention with consistent effort.

Whilst post-comment comparison is suited to establish the sentiment baseline of the community, partitioning the database uncovered further valuable characteristics. It was found that LIWC topics represent

an efficient factor for tracking communal sentiment. The way a Facebook page is administrated also seems to affect indicators contributing to well-being. Revelation of differences through sentiment results is a first step to help administrators of relatively 'unhappy' pages within the community adopt successful traits of similar pages. Detecting event impacts on emotive well-being of communities is a powerful aspect of BeWell, as it does not only provide more information about the community dynamics but can be used to analyze specific events (e.g. policy impact). Finally, shifting focus to time intervals evoked evidence that LIWC can reveal sentiment cycles and advise site administrators when higher activity is most efficient.

Future Work and Limitations
The interpretation of LIWC results of the university Facebook pages revealed diverse social indicators which help to understand the community and its characteristics. The workflow of BeWell empowers researchers to unobtrusively select, analyze and compare communities of interests.

Some limitations caused by the tools available do exist. LIWC was not designed for Online Social Media data, even though it copes astonishingly well with such text. A possible extension would be creating a dictionary with common abbreviations, phrases and emoticons that are pervasive in short, informal online texts (see [12]). Also, an improvement to the performance of the German dictionary with respect to special characters is desirable.

BeWell has provided first evidence that it is sensitive to sentiment peaks induced by short term events and time intervals. Calibration of these characteristics of events
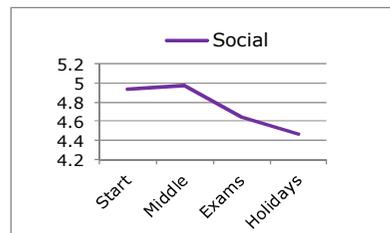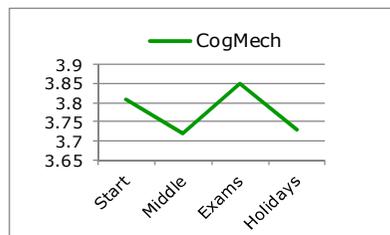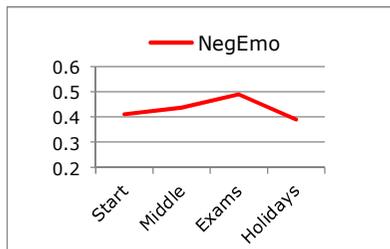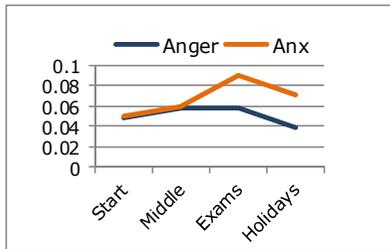
Figure 4a-d. Seasonal peaks of emotions in comments and posts according to semester schedules

and time frames are in process to allow for automated identification. The next step is creating an automated sentiment feedback tool for use in participatory decision making. A deeper understanding of the emotional motivation behind online participation behavior is inevitable to improve the user friendliness of participatory platforms. Personalization simplifies the use of such platforms and keeps the user motivated to participate. Value Sensitive Design [7] can help to include important (ethical) values of all stakeholders. Hence, it would be possible to include indirect stakeholders such as non-participating staff and students. Envisioned is an open dashboard fed by Facebook and other feeds. This can be used to highlight community mood and might for example, combined with an adaptive process, lead the users through the platform depending on their personal current mood. Therefore the participatory interaction within the group is facilitated. In support of institutional efforts this anticipates a happier, healthier community.

Acknowledgements

References

[1] Bhutan, K. of. *Gross National Happiness Index Explained in Detail.* Thimphu, Bhutan, 2012.

[2] Boulianne, S. Does Internet Use Affect Engagement? A Meta-Analysis of Research. *Political Communication 26*, 2 (2009), 193–211.

[3] Brandt, M. Nicht mehr exzellent. *Deutschlandfunk*, 2013, 2. http://www.deutschlandfunk.de/nicht?mehr?exzellent.680.de.html?dram:article_id=240282.

[4] Chung, C.K. and Pennebaker, J.W. Counting little words in Big Data: The Psychology of Communities, Culture, and History. In J. Forgas, O. Vincze and J. Laszlo, eds., *Social Cognition and Communication*. Psychology Press, New York, New York, USA, 2014, 25–42.

[5] Escher, T. Mobilisierung zu politischer Partizipation durchdas Internet. Erwartungen, Erkenntnisse undHerausforderungen der Forschung. *Analyse und Kritik 2*, (2013), 449–476.

[6] Frey, B.S. and Stutzer, A. *Happiness and Economics: How the Economy and Institutions Affect Human Well-Being.* Princeton UP, Princeton, NJ, 2001.

[7] Friedman, B., Kahn Jr., P.H., and Borning, A. Value Sensitive Design and Information Systems. In K.E. Kima and H.T. Tavani, eds., *The Handbook of Information and Computer Ethics*. Wiley, Hoboken, NJ, 2003, 69–102.

[8] Hall, M., Glanz, S., Caton, S., and Weinhardt, C. Measuring Your Best You: A Gamification Framework for Well-being Measurement. *Third International Conference on Social Computing and its Applications*, IEEE (2013), 277–282.

[9] Lin, H. and Qiu, L. Two Sites, Two Voices: Linguistic Differences between Facebook Status Updates and Tweets. *CCD/HCII 2013 Part II*, LNCS 8024 (2013), 432–440.

[10] Stiglitz, J., Sen, A., and Fitoussi, J.-P. Report by the Commission on the Measurement of Economic Performance and Social Progress. *SSRN Electronic Journal*, (2009).

[11] Tausczik, Y.R. and Pennebaker, J.W. The Psychological Meaning of Words: LIWC and Computerized Text Analysis Methods. *Journal of Language and Social Psychology 29*, 1 (2010), 24–54.

[12] Wolf, M., Horn, A.B., Mehl, M.R., Haug, S., Pennebaker, J.W., and Kordy, H. Computergestützte quantitative Textanalyse. *Diagnostica 54*, 2 (2008), 85–98.