

We Feel Fine and Searching the Emotional Web

Sepandar D. Kamvar
Stanford University
sdkamvar@stanford.edu

Jonathan Harris
Number 27
jjh@number27.org

ABSTRACT

We present *We Feel Fine*, an emotional search engine and web-based artwork whose mission is to collect the world's emotions to help people better understand themselves and others. We Feel Fine continuously crawls blogs, microblogs, and social networking sites, extracting sentences that include the words “I feel” or “I am feeling”, as well as the gender, age, and location of the people authoring those sentences. The We Feel Fine search interface allows users to search or browse over the resulting sentence-level index, asking questions such as “How did young people in Ohio feel when Obama was elected?” While most research in sentiment analysis focuses on algorithms for extraction and classification of sentiment about given topics, we focus instead on building an interface that provides an engaging means of qualitative exploration of emotional data, and a flexible data collection and serving architecture that enables an ecosystem of data analysis applications. We use our observations on the usage of We Feel Fine to suggest a class of visualizations called Experiential Data Visualization, which focus on immersive item-level interaction with data. We also discuss the implications of such visualizations for crowdsourcing qualitative research in the social sciences.

Categories and Subject Descriptors: H.5.2 Information Interfaces and Presentation: User Interfaces, H.4.m Information Systems: Miscellaneous

General Terms: Design, Human Factors

Keywords: Sentiment Analysis, Social Media, Search, Computational Social Science

1. INTRODUCTION

The growth of the social web and the corresponding rise in available emotional text over the past several years has led to an increased interest in sentiment analysis. Research in sentiment analysis has concerned itself primarily with algorithms for the extraction of text spans that contain a viewpoint and the classification of those text spans [20]. Typical motivating applications have been technologies that help consumers make purchase decisions, for example, classifying a movie review as “thumbs up” or “thumbs down” [19]. However, the large-scale availability of emotional text – especially when coupled with the availability of demographic information from social media profiles – gives us the ability

to do much more than make better decisions about products or politicians. It gives us the ability to better understand emotions themselves.

In this paper, we present *We Feel Fine*, a project that aims to collect the world's emotions to help people better understand themselves and others. Since August 2005, We Feel Fine has been harvesting human feelings from a large number of weblogs. Every few minutes, the system searches the world's newly posted blog entries for occurrences of the phrases “I feel” and “I am feeling”. When it finds such a phrase, it records the full sentence and identifies the “feeling” expressed in that sentence (e.g. sad, happy, depressed, etc.). Because blogs are structured in largely standard ways, the age, gender, and location of the author can often be extracted and saved along with the sentence. The result is a database of several million feelings, increasing by 10,000 - 15,000 new feelings per day. Using a series of playful interfaces, the feelings can be searched and sorted across a number of demographic slices, offering responses to specific questions like: do Europeans feel sad more than Americans? Does rainy weather affect how we feel? And so on.

We developed We Feel Fine in 2005-2006 and launched it in May 2006. From launch until time of submission, We Feel Fine has collected over 14 million expressions of emotion from 2.5 million people, has been used by 8.5 million visitors, and has been exhibited in several museums, including the Victoria and Albert Museum (London), the National Museum of Contemporary Art (Athens), and the Museum of Fine Art (Houston). We Feel Fine is available at www.wefeelfine.org.

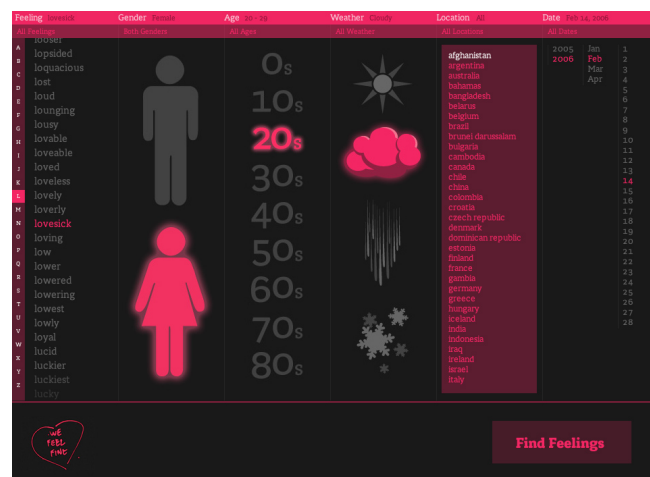


Figure 1: We Feel Fine Search Panel

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. To copy otherwise, to republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee.

WSDM'11, February 9–12, 2011, Hong Kong, China.

Copyright 2011 ACM 978-1-4503-0493-1/11/02 ...\$10.00

2. DESIGN CONSIDERATIONS

Our goal with We Feel Fine was to enable both a qualitative and statistical exploration of other people's emotions. Our belief was that statistical analyses would support a cognitive understanding of emotional patterns, while immersive interaction with individual stories would support a more visceral understanding of the nature of emotions. This latter focus on intuitive understanding through qualitative exploration is a markedly different approach from most work in sentiment analysis, which largely focuses on algorithmic analysis of sentiment text around a given topic.

We found that creating an immersive means of interacting with individual data items directly affected the end user in line with our mission of helping people to understand themselves and others. Further, the qualitative and statistical exploration of data that is personal and universal appealed to a broad set of users, enabling crowdsourced data analysis. We discuss these effects in Section 6; in this section we discuss the principles that engendered these effects. We considered the following principles in our design:

1. **Sentence-level analysis.** The basic atom of the informational web is the web page, so it is natural for informational search engines to analyze and return pages. On the social web, the basic unit is often much shorter – the post or tweet or short social network message. Further, people often express emotions at the sentence-level; rarely is an entire document about a single emotion. For these reasons, we use sentences rather than web pages as the canonical “documents” in the search engine.
2. **Indexing context.** Through public profiles and timestamps, there is much useful context to an emotion outside of the words in the expression itself, for example, the time of the emotion, or the location, gender, and age of the person expressing the emotion. Appropriate index and interface design enable users to ask questions like: “how do women feel right now?” or “how did people in the U.S. feel on September 11th?”
3. **Sentiment as the primary organizing principle.** Most sentiment analysis search engines aim to understand more about certain topics by exploring the prevailing emotions around those topics. With We Feel Fine, the primary aim is to understand more about emotions themselves. As such, we focus on sentiment as the primary organizing principle. This dictates a wide range of design decisions. For example, we use a faceted search interface that focuses on emotions and people rather than a free-form search box, and we index a wide range of emotions rather than simply classifying emotions as positive or negative.
4. **De-emphasizing ranking.** While factual information can be ranked by validity or authority of the source, it is much more difficult to rank sentiment. In keeping with the old adage “feelings are never wrong”, thousands of different expressions can be equally reasonable responses for a query like “how do you feel about going to college?” For this reason we don't introduce the notion of ranking in We Feel Fine.
5. **Emphasizing browsing and summarization.** Rather than ranking expressions of emotion, we prefer to to

summarize them — allowing the user to quickly get the gestalt of how a population feels. Further, since users can gain intuition through qualitative exploration of a population, we aim to provide easy browsing as well.

6. **Enabling the user to easily shift between macro and micro.** In the last bullet, we emphasized the ability to see data at the macro-level (summarization) and the micro-level (browsing). It's also important to allow the user to easily shift between the two. In shifting from micro to macro, the user can better understand trends exposed through summarization. And in shifting from micro to macro, the user can generalize intuitions gained from browsing. Where possible, we wish to create graphs from individual clickable atoms of data (macro to micro transition). And we wish to label items of data with search terms, allowing the user to easily summarize or see more data of that type (micro to macro transition).
7. **Visualizations that reflect the data.** The interface should be functional, but not cold — after all, this is a search engine about emotions. An ideal UI should reflect the subject matter, and in this case, we crafted the elements of the visualization to have human qualities to reflect the people they represent.
8. **Direct Access to the Data.** We recognize the value of We Feel Fine's underlying data for social scientists, particularly those interested in large-scale studies of emotion. We also recognize the difficulty in designing an interface that is intended to be both an artwork and a scientific tool. It is with this in mind that we built a data API for direct data access.

3. ARCHITECTURE

The architecture of the We Feel Fine system is composed of five main components, the *Crawler*, the *Indexer*, the *Data Store*, the *Web Server*, and the *Client Applications*. We give a brief overview in this section. We describe the user interface in more detail in Section 4 and data analysis components at greater depth in Section 5.

Crawler. A *URLServer* (1) collects the URLs of pages to be crawled. These pages contain blog posts, microblog feeds, and pages with public social network messages. URL extraction and collection is site-specific; for example, LiveJournal has a “recently posted” API, while for MySpace, we crawl the friend graph. The *URLServer* sends the list of urls to the *Crawler* (2), which fetches the pages from the web. At the moment, the *Crawler* is a single dedicated machine, but has been designed so that we can easily add more crawling machines if desired.

Indexer. The *Crawler* then sends the fetched pages to the *Feeling Indexer* (3), which extracts the feeling sentence or sentences, the time and date of the post, and any demographic information (such as gender, age, and location). Currently, the *Feeling Indexer* does extraction by matching hand-crafted regular expressions, although certainly there are more sophisticated techniques that may be used. The *Feeling Indexer* sends the sentence to the *Emotional Lexicon*, which determines whether there is a feeling word in the sentence (like “happy,” “sad,” etc.), and if so, sends the

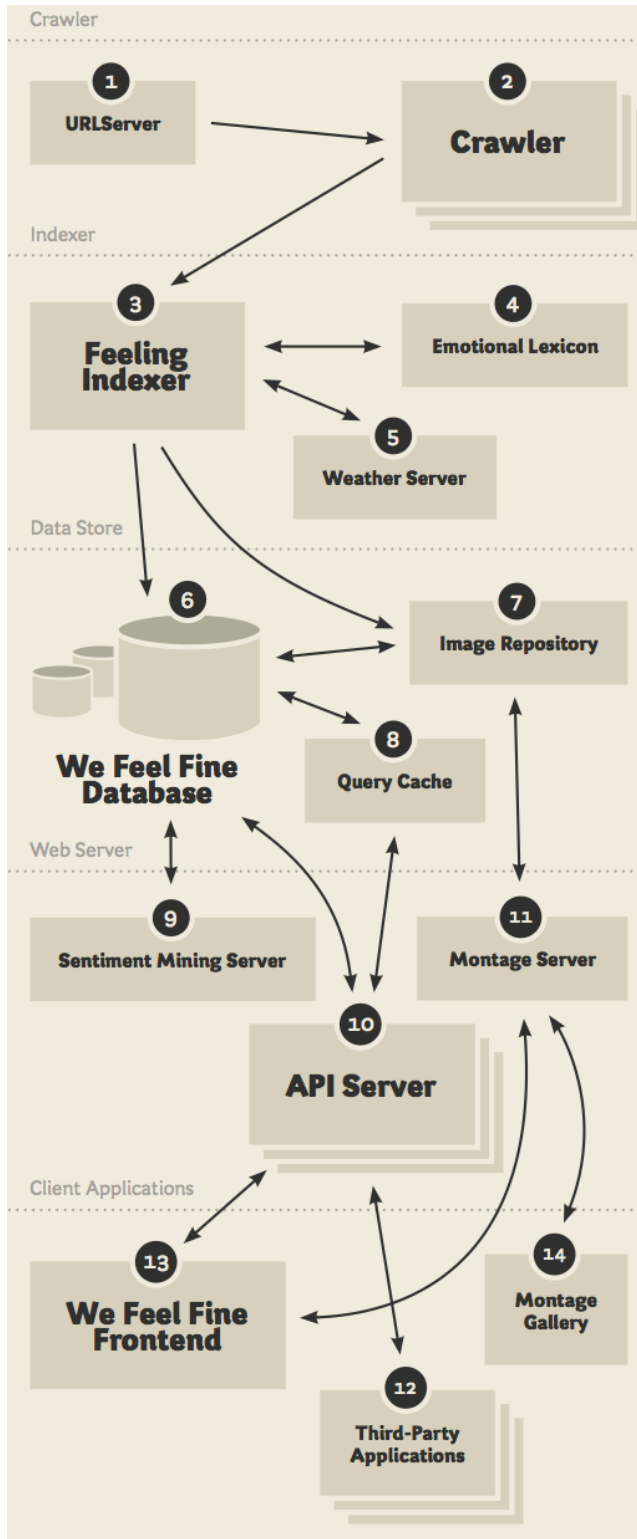


Figure 2: We Feel Fine Component Diagram

feeling word(s) back to the Feeling Indexer. If there are images in the post, the Feeling Indexer determines the largest image in the post (by file size) and sends it to the *Image Repository* (7). For those posts where the location is specified, the Feeling Indexer sends the location, time, and date

of the post to the *Weather Server* (5), which determines the weather using several public weather databases.

Data Store. When the Feeling Indexer has finished processing the URL, it send the feeling sentences and metadata to the *We Feel Fine Database* (6), a MySQL database that stores the emotional data, including sentence, feeling, date, time, URL, weather, and author gender, age, and location. At the moment, the We Feel Fine Database is a replicated database server that has been designed to be easily sharded by date range if desired.

Web Server. Several components communicate with the We Feel Fine Database. The *API Server* (10) defines a RESTful API, translating specified URLs into SQL queries, and then returning the SQL results to the browser as XML. To decrease query latencies, we cache the most common queries and store the results in the *Query Cache* (8). The *Sentiment Mining Server* (9) consists of a set of functions that post-process the results of an API query, computing statistics on the data set on-demand. The *Montage Server* (11) allows the generation of image/sentence composites, called montages. Given a sentence id, the Montage Server will return the feeling sentence overlaid on the largest image from the same blog post. If there are no images on the same post, it will simply return the sentence.

Client Applications. The *We Feel Fine Frontend* (13) is a Java applet written using Processing [7]. It translates user actions into API queries and sends them to the API Server, and translates the returned XML-formatted results into interactive visualizations. The We Feel Fine Frontend is described in depth in Section 4. Users may choose to save a montage from the applet to the *Montage Gallery* (14), a gallery of user-saved montages. And finally, since the API is public, there are dozens of *Third-Party Applications* (12) that use the API.

4. USER INTERFACE

4.1 Design

The We Feel Fine Frontend is a Java applet intended to encourage item-level data exploration, as well as some shallow statistical exploration. It is composed of six movements — called Madness, Montage, Murmurs, Mobs, Metrics, and Mounds — each giving a different view of a sample population selected by a Search Panel.

Search Panel. The Search Panel (Figure 1) allows the viewer to choose the sample population on screen. The red bar at the top of the screen presents a summary of the current sample population. Clicking the bar causes the panel to open, and viewers can select the population along any combination of the following axes: Feeling, Age, Gender, Weather, Location, Date. The faceted interface of the Search Panel reflects Principles 2 and 3 in Section 2. The focus is on searching for emotions or populations, and the various facets are made possible by indexing context.

Madness. Madness, the first movement, is a playful interface to interact with individual data items. It opens with a swarming mass of 1500 particles, emanating from the center of the screen and then careening outwards, bouncing off walls and reacting to the behavior of the mouse. Each par-

ticle represents a single feeling. The color of each particle corresponds to the tone of the feeling inside — happy feelings are bright yellow, angry feelings are red, and so on. Any particle can be clicked at any time, revealing the sentence inside (along with the photo if there as one) and information about the sentence’s author. As the particles move around the screen, they lose speed and eventually freeze as they approach the mouse cursor, allowing them to be clicked. As the particles approach the bottom left corner of the screen, they become attracted to it and swarm around it, drawing the eye to a menu that gives access to the other five movements of We Feel Fine.

The design of the Madness movement was motivated by Principle 7 in Section 2. The tiny colorful particles represent a bird’s eye view of humanity — like standing atop a skyscraper and looking down at the street. People bustle to and fro, darting in and out of shops, hailing taxis, falling in love, laughing, handling personal crises. From the skyscraper, the notion of individuality is hard to recognize. However, once a particle is clicked, it explodes into its constituent letters, which form its sentence, and that particle becomes the center of attention. At this moment, the viewer sees the open sentence as the only one that matters.

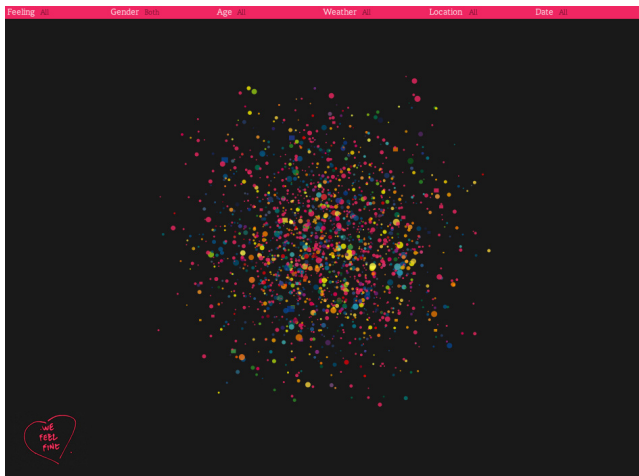


Figure 3: Madness

Murmurs. Murmurs presents a structured environment in which to view feelings. As this movement begins, every particle on screen gently floats upwards, eventually bouncing off the ceiling several times before settling. Then, one by one, the particles drop from the ceiling to join a simple scrolling list of feelings, organized in reverse chronological order. The sentences appear letter by letter, as if being typed by their author, and fade to black as new sentences appear. The strict formal constraints of Murmurs help to emphasize the polarities in the types of feelings present in the world. Some are mundane, some are funny, some are poignant. As they march along, the feelings begin to strike a common chord.

Montage. Montage presents the feelings from a given population that contain photographs, and displays these photographs in a simple grid of variable size, depending on the number of photographs available. Any photograph in the grid can be clicked, causing it to zoom in to the size of the screen. When zoomed, a photograph’s associated sentence

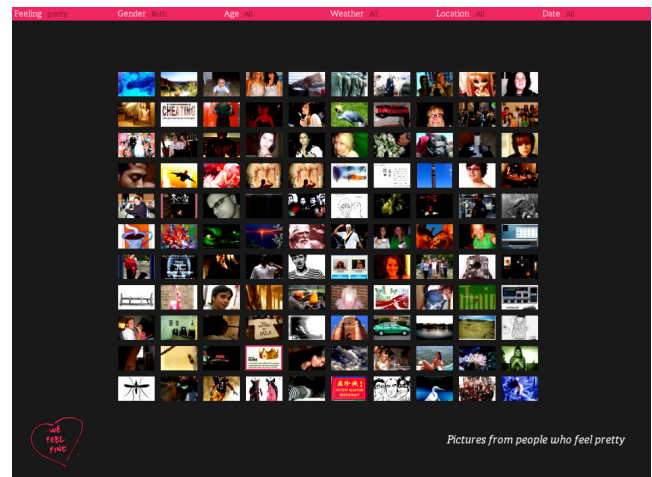


Figure 4: Montage

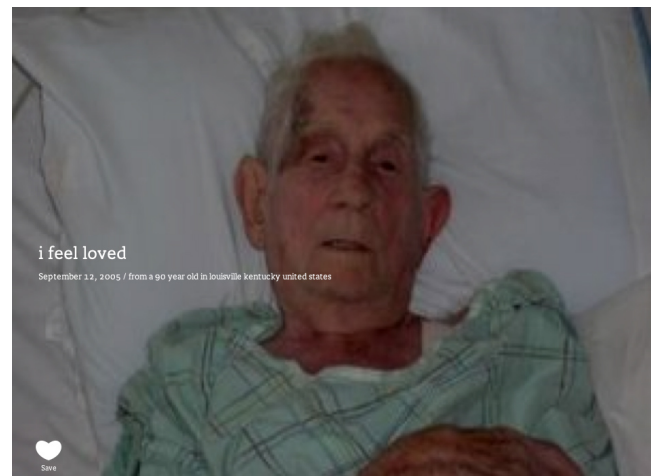


Figure 5: Individual Montage

is revealed. Any user may save a montage to the Montage Gallery, allowing anonymous viewers of We Feel Fine to collaboratively curate an exhibit of beautiful, surprising, or otherwise interesting images.

Mobs. Mobs consists of five smaller movements, each of which uses the particle system to configure its shape, color, distribution and physics to best express the different zeit-geists of: feeling, gender, age, weather, and location. For example, *Mobs (Feeling)* displays the most common feelings in the sample population on a histogram. In each of the other Mobs movements (Gender, Age, Weather, and Location), the particles similarly self-organize to form summary graphs. In *Mobs (Location)* (Figure 7), for example, they arrange themselves on a map. This movement aims to summarize the data set as per Principles 4 and 5 in Section 2. Consistent with Principle 6 we enable macro to micro transitions by allowing the user to click on any particle in a graph to see the underlying feeling sentence.

Metrics. Metrics, the fifth movement, consists of five smaller movements. While Mobs expresses the features that are most frequently expressed in the sample population, Metrics expresses the features that are most differentially expressed

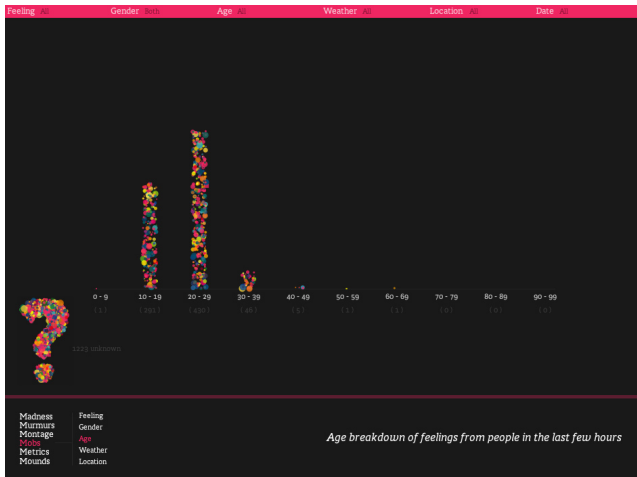


Figure 6: Mobs (Age)

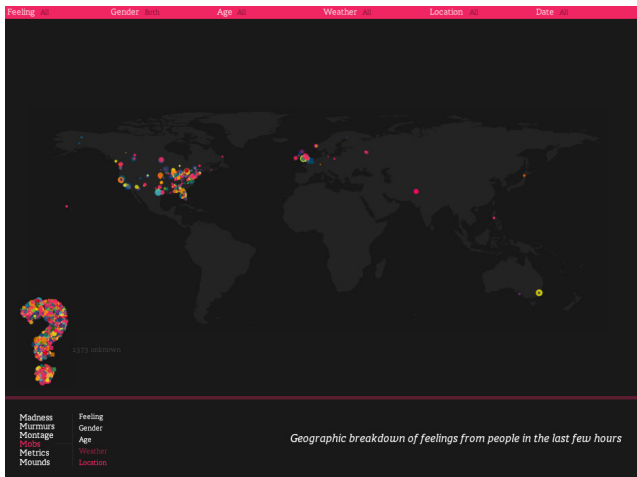


Figure 7: Mobs (Location)

from the global average. For example, Mobs shows that the feeling ‘better’ is almost always the most commonly expressed feeling in any sample population, because it is such a common feeling. In Metrics, however, ‘better’ will only be listed if it’s much more expressed in the sample population than it is in a randomly sampled population.

Mounds. Mounds, the final movement, is independent of the sample population, always displaying every feeling in our database, scaled and sorted in order of frequency. Each feeling is portrayed as a large bulbous mound, colored to correspond to the feeling it represents. The mounds jiggle slightly when undisturbed, and bend away as the mouse cursor approaches their perimeter. A small scrollbar below the mounds allows the viewer to jump to a specific point in the feelings list. Above each mound is listed its feeling, along with its and the total number of occurrences in the database.

4.2 Usage Observation

To evaluate our design, we observed usage in an informal laboratory setting. Additionally, as We Feel Fine has been discussed extensively in the blogosphere by its users, we found it useful to examine the the blog posts and blog comments

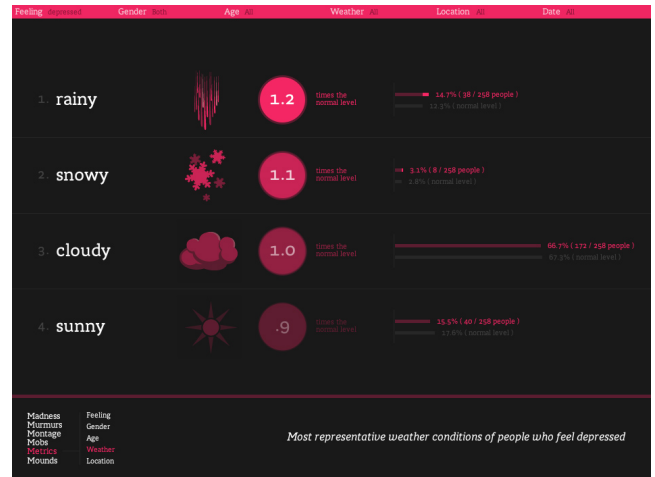


Figure 8: Metrics (Weather)

discussing We Feel Fine. These posts and comments are clearly not a scientific sample, as only a small fraction of the most highly enthusiastic or web-savvy users will blog or comment about an application that they’ve used. Nonetheless, we found that this examination was a useful complement to the lab study, both in reinforcing some findings from the lab study, and suggesting further hypotheses. In fact, we were surprised at the extent to which the comments from participants in the lab study were similar to comments on blogs discussing We Feel Fine. We drew inspiration and methodology for the two studies from [11] and [25].

The participants of the lab study consisted of 10 males and 10 females, ages 18-61, of varying levels of internet expertise. To maintain ecological validity, we did not give the users any specified tasks, nor did we require them to read the detailed description of the applet available on the website. Rather, we told them to spend 15 minutes exploring the site, and to talk through their exploration. We video recorded the screen and audio recorded the user’s comments. We interviewed the subjects afterwards.

While we imagined that we would get feedback on usability of the visualization, we were surprised to find that the users were far more inclined to talk about the emotional effects of the underlying data itself. There were two strong patterns: an increased emotional self-awareness and an increased sense of connection to others.

Emotional Self-Awareness. Almost all participants in the study exhibited a heightened self-awareness and self reflection of their own emotions. In almost every user study, the subject started talking about how she felt around the middle or end of the session, even though we did not prompt them to do so. One participant in the study said:

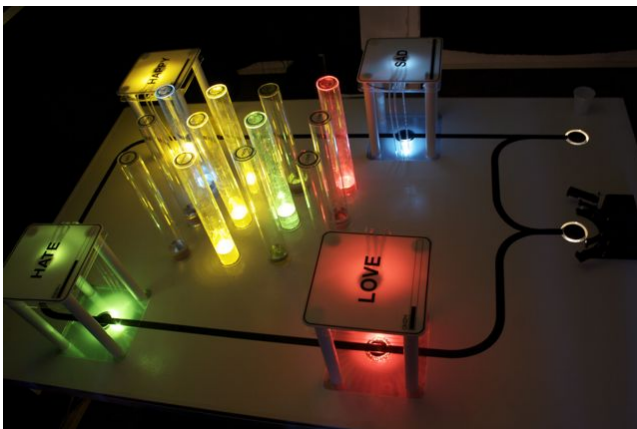
“Now I just want to give a little personal note here. I am sitting here in the afternoon reading these really deep esoteric statements by people from who knows where and I’m really enjoying myself right now. It feels surreal, sitting here talking to somebody who I have just met and will not see again and seeing the emotions of people who I do not know or will not meet. I feel pretty good.”



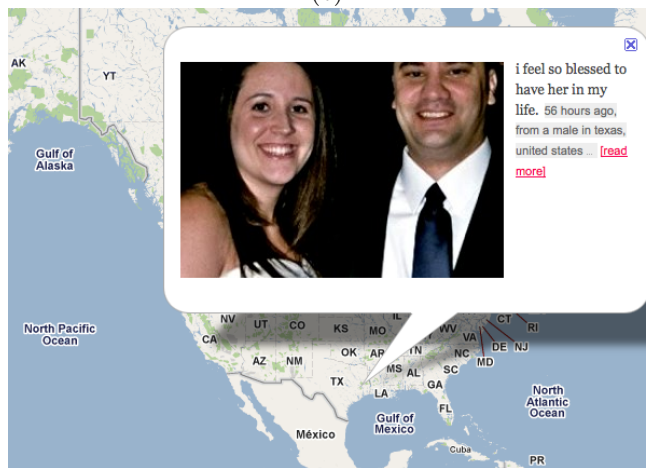
(a)



(b)



(c)



(d)

Table 1: Some uses of We Feel Fine API: (a) a prayer tool for nuns in a convent in England, (b) The Arhus city tower in Denmark, lit up according to how Denmark was feeling at any moment, (c) a robot that mixes the user a drink based on the sample population the user chooses, and (d) a mashup with Google maps, showing Feelings around the world.

This heightened emotional self-awareness was echoed in the blogs that discussed We Feel Fine. It was very common for a blog post describing We Feel Fine to end with how the blogger was feeling (and many of them emphasized the words “I feel”). For example:

I feel happy, tired, and lucky to have such great friends (online and offline).

Interestingly, the commenters on these blog posts would also often chime in with how they were feeling, resulting in a stream of feelings in the comments section. Many participants in the study also noticed that their own emotions mirrored those of the people in the piece:

“I searched the word ‘abhorrent’ and I actually felt a little of what the bloggers were feeling. I felt I needed to get to a different (non-negative) feeling soon after reading the sentences. And, of course, I felt fat (which I am) when I searched for that feeling. This is very interesting to me.”

Empathy. In addition to self-awareness, the participants also reported a feeling of connection and empathy. In many of the sessions, the subjects talked back to a feeling sentence in the applet as if it were the person:

Applet: “I feel like I’m way too abrasive or mean to people.”
Participant: “Well, that’s very honest of you.”

In the interviews afterwards, several participants expressed feeling “empathetic,” “close,” “more connected,” and “less lonely”. One participant noted:

“I could see myself using this to find people who are feeling bad and try to cheer them up.”

And many participants and bloggers commented that they project their own experience on to the emotions that they see. One blogger noted:

“While using We Feel Fine, I see the words ‘I feel scared because...’ and I immediately recall what that feels like. Suddenly my experience becomes much more personal and I feel connected with a person I have never met. I then observe thousands of other dots like it and my thoughts are bouncing between this micro and macro level of connectivity.”

Study participants and bloggers described feeling a sense of connection and belonging to the world around them.

“It is comforting if you are feeling down to search by ‘sad’ or ‘sorry’, and see millions of others who share your sentiment. You feel less alone and the world seems smaller.”

“I feel that witnessing everyone’s feelings of failure and success gives me a keen sense of belonging in the world.”

Perhaps as a result of both the feelings of self-awareness and connection, several people in the study expressed feeling calm, relaxed, or grounded after their exploration. Some describe an increased ability to manage their own emotions. One study participant noted:

“I feel much more relaxed right now than I have certainly today and probably all week. I feel like I can take a breath and look outside and actually enjoy the rain. A little while ago it was just annoying me, because it meant I had to do cleanup in the yard and all the other things that responsibility entails instead of enjoying what’s going on in the world and smelling the roses.”

5. API

While the We Feel Fine frontend gives the user a qualitative view of emotions (along with some shallow statistics), large-scale quantitative analysis of the data requires different tools. To support such statistical analyses, we built the We Feel Fine API and Sentiment Mining Server.

5.1 Design

We Feel Fine’s API consists of two components: a RESTful API that returns data given a query, and a Sentiment Mining Server that computes basic statistics over an API query. The API is an RESTful API that translates a url to a SQL query on the We Feel Fine database, and returns the results in XML, HTML, CSV, or plain text. A user may query by feeling, gender, age range, weather conditions, location, and date. The API returns the feeling sentence and any additional information requested by the user. The API is open and documented at <http://wefeelfine.org/api.html>. The Sentiment Mining Server consists of a set of functions that postprocess an API query to compute elementary statistics on the data set. It includes functions that:

- return the feeling frequency histogram for a given query
- return the word frequency histogram for a given query
- give the demographic breakdown for feelings expressed by a given query
- give a time breakdown for feelings expressed by a given query (by date, month, year, and day-of-week)
- categorize feelings into the eight principle emotions as described in Plutchik [21].
- categorize feelings into positive or negative
- score sentences for valence, arousal, and dominance based on the ANEW [1] scoring system.
- compare any of the above functions to a reference query, so that, for example, the user can see if a certain feeling is overexpressed as compared to average.

What is remarkable about the We Feel Fine data serving infrastructure is how expressive it is given its simplicity. The data collected by We Feel Fine uses regular expression matching for information extraction rather than more sophisticated extraction methods [20, 16]. And the statistical tools provided by the Sentiment Mining Server give only frequencies and hand-assigned categorizations. Nevertheless, the API and Sentiment Mining Server support a wide array of uses, and We Feel Fine has been surprisingly accurate both in replicating existing results in the psychology literature [12] and in suggesting new hypotheses that have then been confirmed by controlled lab experiments [17]. Some examples use cases are described below.

5.2 Usage Observation

The Meaning of Happiness. The study by Mogilner et al. [17] on the “meaning” of happiness is one of the most interesting

examples of how We Feel Fine works in tandem with traditional experimental methods in emotions research. The We Feel Fine data showed that the co-occurrence of excited feelings and happy feelings decrease as people grow older, while the co-occurrence of peaceful feelings and happy feelings increase. This was tested by a controlled lab experiment where a group of subjects were influenced to feel excited or peaceful, and then measured for their happiness levels afterwards. In the lab study, younger people felt happier when influenced to feel excited, while older people felt happier when influenced to feel peaceful [17].

Hedonometer. Dodds and Danforth [4] have built a “hedonometer” based on We Feel Fine data and the ANEW scoring system [1], computing a happiness score for any population. Using this hedonometer, they measured happiness levels in the United States over time, and correlated it with the happiness measures from song lyrics and presidential addresses.

The Emotions of Aging. One of the most pronounced results to come from our own study of this data set was how people’s emotions vary with age [12]. Figure 9 shows that people express considerably less anger, disgust, and sadness as they get older. This is consistent with the psychology literature [15], but allows for greater granularity in determining, for example, what kinds of sadness decrease most.

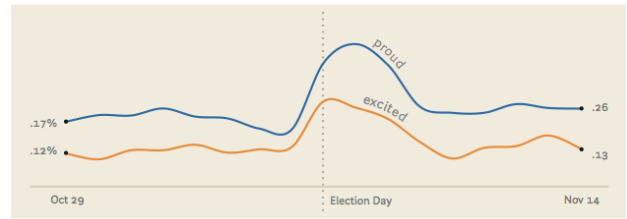
Time-series Analyses. Figure 10 shows several time-based analyses of emotions [12]. When Obama was elected on November 4th, 2008, there was a spike in the feeling “proud” — it was the proudest day on record since we started collecting emotions in 2005. There were also spikes in “excited” and “hopeful” and a smaller spike in “depressed.” On Valentine’s Day, we see a recurring spike in people feeling “loved” and “special”, and also a spike in people feeling “lonely.” We also see a marked difference in stress between the week and weekend, and happiness expressed in the morning vs. night.

The Emotional Graph. Figure 11 shows emotions that are frequently co-expressed in the same sentence [12]. It shows that there are strong relationships between anger and depression, disgust and shame, and happiness and gratitude. Moreover, it shows that broadly, positive feelings tend to not co-occur often with negative feelings, with a few exceptions. While there exist studies that show connections between anger and depression [18] and gratitude and happiness [24], this graph suggests links that are less well-studied, such as pride and shame.

Artistic Purposes. The API has been also used widely for artistic and emotional purposes. For example, Gaver et al. [8] designed a “Prayer Companion” as a resource for the spiritual activities of a group of cloistered nuns in Northern England. Podenphant [22] created an installation in which he lit up the historic Aarhus, Denmark city hall tower according to how people were feeling at any time in Denmark. And Molenaar and Grob created a robot that mixes a drink for a user based on the feelings returned by the user’s We Feel Fine Query.

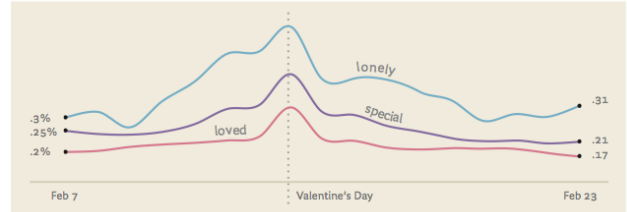
6. DISCUSSION

Perhaps the most interesting contribution of We Feel Fine is in its focus on engaging the user at an emotional level.



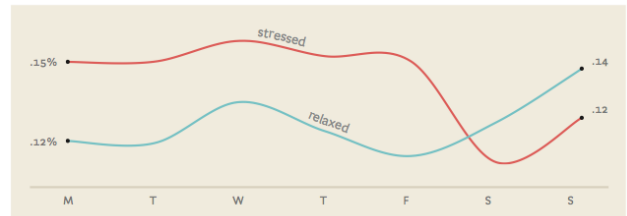
Obama's Election Day / Nov. 4, 2008

There was a dramatic spike in excitement and a swelling sense of pride, which lingered for several days after the election, during the palpable state of national euphoria.



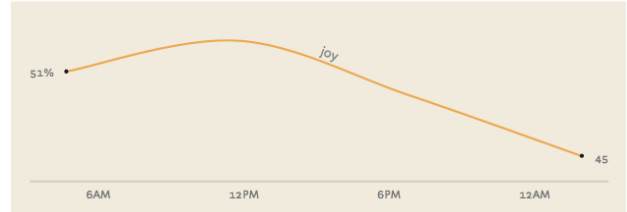
Valentine's Day / 2006-2008 average

Loneliness sees the biggest rise, starting a few days before Valentine's Day and remaining high for a few days afterwards. Feeling special and loved is also typical of the holiday.



Stressful Weeks

Stress is high throughout the work week, but begins to decline on Friday, just as relaxation starts to rise, climbing to its Sunday high. Stress begins again on Sunday.



Joyful Mornings

Joy is high in the morning, and peaks just before lunchtime, before beginning its steady decline through the rest of the day as food coma and fatigue set in.

Figure 10: Time Series Analyses

While we chose to do so because it seemed appropriate in a tool intended to study emotions, it has had a couple of unintended and broad-reaching consequences. First, it showed that exposition of data can confer non-cognitive benefits, suggesting new areas for data visualization. Second, the emotional effect of the visualization led to broad and extensive usage that effectively involved millions of people in small-scale qualitative research on emotion. Both of these merit further discussion.

6.1 Experiential Data Visualization

Our aim for We Feel Fine was to collect the world’s emotions to help people better understand themselves and others. It appears to have succeeded in this aim in a surprising way. While data visualization has been defined as a tool to amplify cognition [2], the primary responses in the user study were affective. Indeed, cultivating emotional self-awareness

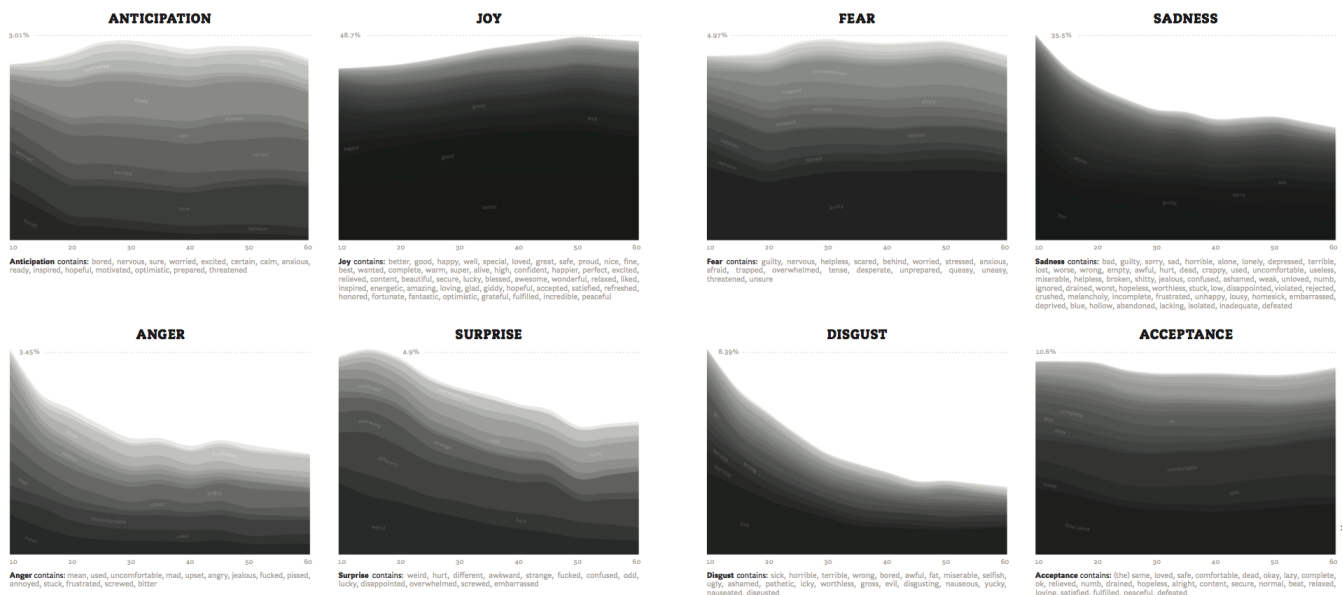


Figure 9: The Emotions of Aging

and empathy are key factors in developing emotional intelligence [23]. This suggests that data visualization can be used for more than exposing patterns in data.

More concretely, the observations from the user study suggest a class of visualizations that we call Experiential Data Visualization. Visualizations of this type would share three properties: first, they would communicate insights that are often simply communicated in words, but much more powerfully communicated by example¹; second, they would focus on interaction models that encourage direct interaction with individual data items; and third, they would focus on influencing affect rather than cognition.

Indeed, we found that the participants in the study who spent most of their time in the Madness and Murmurs movements were more likely to describe the applet as “calming” and “grounding” and their post-study observations were more likely to be along the lines of “It really changed my mood which was surprising” while participants who spent most of their time in Mobs, Metrics, and Mounds movements were more likely to describe the applet as “interesting” or “intriguing”, and their observations were more likely to be along the lines of “It was interesting that the feeling ‘blessed’ was more prevalent on Christmas.”

We suggest that the design principles described in Section 2 are useful guiding principles not just for We Feel Fine, but for Experiential Data Visualization in general. In particular, Principles 1 and 4-7 give visualization mechanisms for immersive interaction with individual data items. In the case of We Feel Fine, Principle 3 ensures that the data influences affect, but for other projects, one may replace Principle 3

¹For instance, one may argue that you don’t need an interactive data visualization to communicate that you are not alone in your emotions. However, that is more powerfully expressed by showing the emotions of others, in the same way that lessons about love are often easily expressed in words, but more powerfully learned by actually being in love.

with a principle that ensures that the data is personal and universal to the target audience. We subsequently used these principles in the design of I Want You To Want Me, an experiential visualization of data from online dating sites [10], and have observed similar results.

6.2 Crowdsourced Data Mining

Over 8 million people have visited We Feel Fine from 2006-2010, each spending an average of close to 4 minutes exploring the data. The time spent on data exploration is equivalent to a staff of over 50 people working full-time manually exploring the data set. This speaks for the potential of crowdsourced data analysis. While users of We Feel Fine are generally not trained data analysts and the time spent in exploration is often short, the insights from the community have been both real-time and sophisticated. For example, we got many e-mails on the day of Michael Jackson’s death noting that there was an unusually high frequency of the feeling ‘sad’, and we continue to get example-backed hypotheses from our users as to the emotional difference between men and women. Indeed, most of our investigations are the result of hypotheses put forth by our users based on their exploration of the data. Other data visualizations have seen similar phenomena of crowdsourced data analysis, most notably NameVoyager [25] and Vizter [11]. What these interfaces share in common are that they explore personal, universal topics (baby names, friends, emotions) in a playful, aesthetically pleasing manner. What is unique about We Feel Fine in this context is that it allows for crowdsourced qualitative research, and many of the insights that people have sent to us include not only statistics, but detailed examples. The principles in Section 2 lend themselves well to this kind of crowdsourced data analysis, particularly Principles 5 and 6.

It’s interesting to note that the crowdsourced qualitative research is made much more compelling and actionable by the existence of the Sentiment Mining Server, with which we can quickly run statistical analyses to corroborate the

crowdsourced hypotheses. Aggregating, communicating, and corroborating the insights of the crowd more seamlessly is an area of future work and has been explored in a different context in [25].

6.3 Related Work

Sentiment Analysis. There is a large body of work in sentiment analysis; an extensive review of such work is given in [20]. Research in this area has focused largely on algorithms for opinion extraction and categorization. This is not the focus of this paper, and We Feel Fine uses deliberately simple methods for extraction and categorization. The contribution of this work to the sentiment analysis literature lies instead in outlining systems architecture and interface design principles for a sentiment analysis search engine, in showing some non-cognitive effects of item-level exploration of sentiment data, and in introducing the idea of crowdsourced sentiment mining.

Computational Social Psychology. Computational techniques for large-scale data-driven experiments in psychology are a fairly new development [13]. Pennebaker et al. have performed linguistic analysis on blogs to study personality and mood, for example, before and after 9/11 [3]. Christakis and Fowler have studied the spread of many emotions over social networks, as in [6]. While much of the existing literature is focused on specific scientific findings by computational means, in this work we are more concerned with developing a robust experimental infrastructure for use by others. We believe that well-designed computational infrastructure to perform large-scale association experiments will have a similar effect on the social sciences as the microarray [5] has had on the biological sciences. In this case, rather than looking at gene expression levels in tissue samples, we look at emotional expression levels in population samples.

Data Visualization. We Feel Fine was inspired in part by Listening Post [9], an installation piece that culls text fragments from online chat rooms in real time and displays them on a grid of several hundred electronic screens. There exist other engaging artistic representations of human communication data as well, as well: The Dumpster [14] visualizes expressions of breaking up from blogs. I Want You To Want Me [10] crawls online dating sites for sentences that start with “I am” and “I am looking for” as well as other snippets. The contribution of this work is in defining a class of visualizations called Experiential Data Visualization, and suggesting design principles for such visualizations.

7. CONCLUSION

To date, most research in sentiment analysis has been focused on algorithms to extract, classify, and summarize sentiment. While this has clearly been useful, there remains a broad opportunity for researchers to build immersive interfaces that allow for item-level exploration of sentiment data. This item-level exploration of data can bring its own experiential benefits to the user, as well as enable crowdsourced qualitative data analysis. Further, while traditional motivating applications for sentiment analysis have been in consumer research and decision-support tools, available sentiment data on the web can be used to build scalable computational tools to support social science research. Such tools have the potential to make a significant impact, allowing

for social science researchers to run inexpensive large-scale studies to generate data-driven hypotheses. We present We Feel Fine as an exploration of these opportunities.

Acknowledgements

We’d like to thank Susan Dumais, Martin Wattenberg, and Mor Naaman for their extensive comments on drafts of this paper.

8. REFERENCES

- [1] M. M. Bradley and P. Lang. Affective norms for English words. *University of Florida Technical Report*, 1999.
- [2] S. Card, J. Mackinlay, and B. Shneiderman. *Readings in Information Visualization*. Morgan Kaufman, San Francisco, 1999.
- [3] M. Cohn, M. Mehl, and J. Pennebaker. Linguistic markers of psychological change surrounding September 11, 2001. *Psychological Science*, 15(10):687–693, 2004.
- [4] P. Dodds and C. Danforth. Measuring the happiness of large-scale written expression: songs, blogs, and presidents. *Journal of Happiness Studies*, 2009.
- [5] S. Fodor et al. Light-directed, spatially addressable parallel chemical synthesis. *Science*, 1991.
- [6] J. Fowler and N. Christakis. Dynamic spread of happiness in a large social network. *British Medical Journal*, 3, 2008.
- [7] B. Fry and C. Reas. *Processing*. MIT Press, Cambridge, 2007.
- [8] W. Gaver et al. The prayer companion. In *CHI*, 2010.
- [9] M. Hansen and B. Rubin. Listening post. *Whitney Museum of American Art*, 2003.
- [10] J. Harris and S. D. Kamvar. I want you to want me. *Museum of Modern Art*, 2008.
- [11] J. Heer and D. Boyd. Vizster: Visualizing online social networks. In *INFOVIS*, 2005.
- [12] S. D. Kamvar and J. Harris. *We Feel Fine: An Almanac of Human Emotion*. Scribner, New York, 2009.
- [13] D. Lazer et al. Computational social science. *Science*, 323(5915):721–723, 2009.
- [14] G. Levin and K. Nigam. The dumpster. *Whitney Museum of American Art*, 2006.
- [15] M. Lewis and J. Haviland-Jones. *Handbook of Emotions, Third Edition*. Guilford Press, New York, 2008.
- [16] A. McCallum, D. Freitag, and F. C. N. Pereira. Maximum entropy markov models for information extraction and segmentation. In *ICML*, 2000.
- [17] C. Mogilner, S. D. Kamvar, and J. Aaker. How the meaning of happiness shifts across the life course. *Social Psychological and Personality Science*, 2010.
- [18] J. Mook et al. Anxiety, anger and depression: Relationships at the trait level. *Anxiety, Stress, and Coping*, 3(1):17–31, 1990.
- [19] B. Pang and L. Lee. A sentimental education: sentiment analysis using subjectivity summarization based on minimum cuts. In *ACL*, 2004.
- [20] B. Pang and L. Lee. Opinion mining and sentiment analysis. *Found. Trends Inf. Retr.*, 2(1-2):1–135, 2008.
- [21] R. Plutchik. *The emotions: facts, theories, and a new model*. Random House, New York, 1962.
- [22] K. Podenphant. I am feeling. 2009.
- [23] P. Salovey and J. Mayer. Emotional intelligence. *Imagination, Cognition, and Personality*, 9:185–211, 1990.
- [24] P. Watkins et al. Gratitude and happiness: Development of a measure of gratitude, and relationships with subjective well-being. *Social Behavior and Personality*, 31(5):431–451, 2003.
- [25] M. Wattenberg and J. Kriss. Designing for social data analysis. *IEEE Transactions on Visualization and Computer Graphics*, 12(4):549–557, 2006.

