COM3110/4115/6150: Text Processing

Sentiment Analysis

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Learning Outcomes

By the end of the SA sessions, you will be able to:

- Explain the relevance of the topic
- Differentiate between objective and subjective texts
- List the main elements in a sentiment analysis system
- Provide a critical summary of the main approaches to the problem
- Explain how sentiment analysis systems are evaluated.

Overview

- **Definition of the problem of sentiment analysis**
- **Approaches to sentiment analysis**
- Evaluation of sentiment analysis approaches

Based on survey and slides by Bing Liu (University of Illinois at Chicago), 2012.

General goal

Certain texts, particularly on the Web, have **emotions** or **sentiments** or **opinions**, e.g.:

- Blogs and microblogs (Twitter, etc.)
- Social networks (Facebook, myspace, etc.)
- User comments, like on Youtube, or on products, like on Amazon
- Review websites, like Rotten Tomatoes, yelp
- Community websites, like Symantec Forums

Size of blogosphere: over 112 million blogs, 75,000 created each day, 1.2 million posts/day [1]
Social networks like Twitter...

[1] `http://technorati.com/state-of-the-blogosphere/`

General goal

Extract **opinions**, **sentiments** and **emotions** expressed by humans in texts and use this information for business, intelligence, etc. purposes. Can't be done manually: huge volumes of opinionated text (esp. Big Data on the Web). Examples of applications:

- Product review mining: Which features of the iPhone 6 customers like and which do they dislike?
- Review classification: Is a movie review positive or negative?
- Tracking sentiments toward topics over time: Is anger about the government policies growing or cooling down?
- Prediction (election outcomes, market trends): Will the Tories win the next election?

Here: opinion = sentiment = emotion
Here: sentiment analysis = opinion mining
Although sentiment doesn't always express opinion: "I am sad today".

Importance of opinions

- Whenever we need to make a decision, we may want to hear others' opinions
- In the past: surveys, focus groups, consultants, opinions from friends and family
- Nowadays: Word-of-mouth on the Web
  - User-generated media: one can express opinions on anything in reviews, forums, discussion groups, blogs ...
  - Opinions of global scale: no longer limited to one's circle of friends (individuals), small scale surveys, focus groups, etc. (businesses)

Importance of opinions

- Individuals: interested in other's opinions when
  - ◇ purchasing a product or using a service,
  - ◇ finding opinions on political or other topics.
- Businesses and organizations:
  - ◇ product and service benchmarking.
  - ◇ market intelligence.
  - ◇ cost reduction: business spends a huge amount of money to find consumer sentiments and opinions with consultants, surveys and focused groups, etc.
- Ad placement: Placing ads in the user-generated content
  - ◇ Place an ad when one praises a product.
  - ◇ Place an ad from a competitor if one criticises a product.

Motivations

"I bought the new iPhone a few days ago. It was such a nice phone. The touch screen was really cool. The voice quality was clear too. Although the battery life is not long, that is ok for me. However, my mother was mad with me as I did not tell her before I bought the phone. She also thought the phone was too expensive, and wanted me to return it to the shop."

What do we see in this text? Positive or negative opinions?

Motivations

"I bought the new iPhone a few days ago. It was such a nice phone. The touch screen was really cool. The voice quality was clear too. Although the battery life is not long, that is ok for me. However, my mother was mad with me as I did not tell her before I bought the phone. She also thought the phone was too expensive, and wanted me to return it to the shop."

Objective sentence

Motivations

"I bought the new iPhone a few days ago. It was such a nice phone. The touch screen was really cool. The voice quality was clear too. Although the battery life is not long, that is ok for me. However, my mother was mad with me as I did not tell her before I bought the phone. She also thought the phone was too expensive, and wanted me to return it to the shop."

Positive and negative opinions about what?

Motivations

"I bought the new iPhone a few days ago. It was such a nice phone. The touch screen was really cool. The voice quality was clear too. Although the battery life is not long, that is ok for me. However, my mother was mad with me as I did not tell her before I bought the phone. She also thought the phone was too expensive, and wanted me to return it to the shop."

Targets of opinions

Motivations

"I bought the new iPhone a few days ago. It was such a nice phone (I). The touch screen was really cool (I). The voice quality was clear too (I). Although the battery life is not long, that is ok for me (I). However, my mother was mad with me as I did not tell her before I bought the phone (mother). She also thought the phone was too expensive, and wanted me to return it to the shop.(mother)"

Holders of opinions

Definitions

Facts versus Opinions

- Current text processing methods (e.g., web search, text mining) work with factual information.
- Current search ranking strategy not appropriate for opinion retrieval.
- Sentiment analysis focuses on subjective statements - opinions, sentiments, emotions: hard to express with a few keywords. E.g. What do people think of Motorola Cell phones?

Excellent phone, excellent service
Just double check with customer service to ensure the number provided by amazon is for the city you wanted
I'd always eyed the nokia phones and had heard decent things about t-mobile, so i gave it a whirl
It costed 500 dollars, not worth the price really
It costed 500 dollars!!!

Subjectivity analysis

Subjectivity classification is often the first step for sentiment analysis: subjective versus objective texts, e.g.:

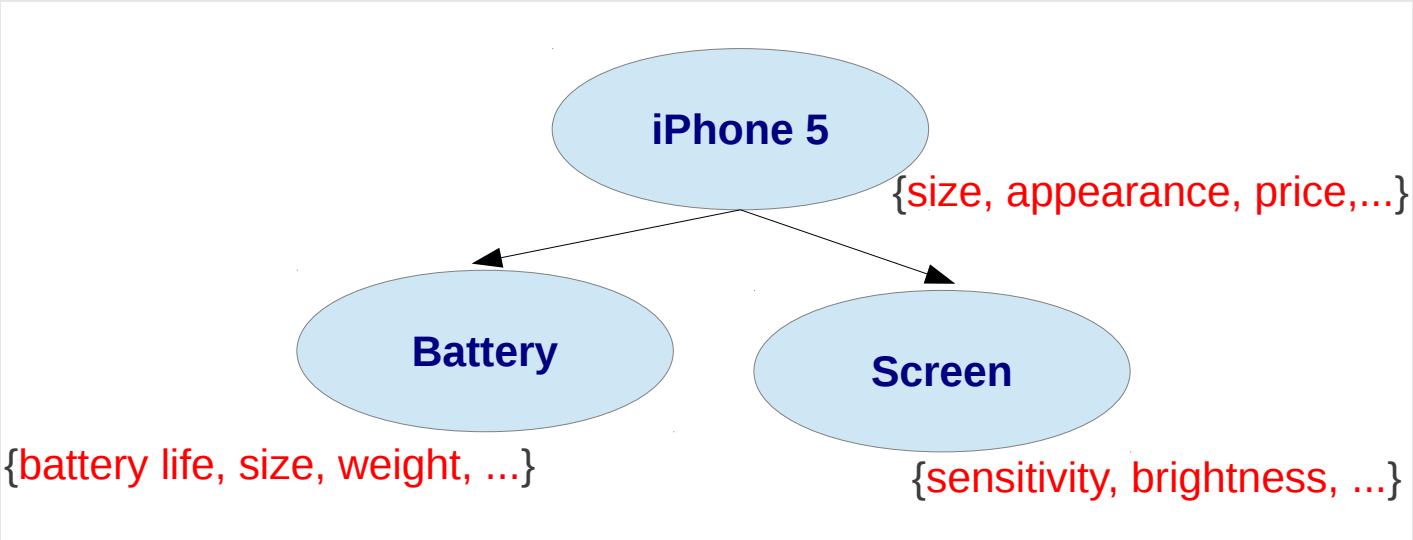
- **Objective**: *I bought an iPhone a few days ago.*
- **Subjective**: *It is such a nice phone.*

However:

- Subjective sentences do not always express positive or negative opinions, e.g.: *I think he came yesterday.*
- Objective sentences can express opinion indirectly, e.g.: *My phone broke in the second day.*

Target objects

- Product, person, event, organization, or topic: *o*. It is represented as
  - ◇ A hierarchy of components, sub-components, etc.
  - ◇ Each node represents a component and has a set of attributes.



An opinion can be expressed on any component or attribute of the component – call them both "**features**" of the object.

Bing Liu's model for Sentiment Analysis

An **opinion** is a quintuple $(o_j, f_{jk}, so_{ijkl}, h_i, t_l)$, where:

- o_j is a target object.
- f_{jk} is a feature of the object o_j.
- so_{ijkl} is the sentiment value of the opinion of the
- opinion holder h_i (usually the author of the post)
- on feature f_{jk} of object o_j at time t_l.
- so_{ijkl} is positive, negative, neutral, or a more granular rating, such as 1-5 stars as in movie reviews.

Sentiment Analysis

For example:

"I bought the new iPhone a few days ago. It was such a nice phone. The touch screen was really cool. The voice quality was clear too. Although the battery life is not long, that is ok for me. However, my mother was mad with me as I did not tell her before I bought the phone. She also thought the phone was too expensive, and wanted me to return it to the shop."

- o_j: iPhone
- f_{jk}: phone, screen, voice quality, battery life, price
- so_{ijkl}: positive, positive, positive, negative, negative
- opinion holder h_i: I, I, I, I, mother
- time t_l: post's date

Sentiment Analysis

The task of **opinion mining** is: given an opinionated document:

- Discover all quintuples $(o_j, f_{jk}, so_{ijkl}, h_i, t_l)$, or
- Discover some of these components

With that, one can structure the unstructured:

- Traditional data and visualisation tools can be used to slice, dice and visualise the results.
- Qualitative and quantitative analysis can be done.

Sentiment Analysis

Granularity level:

- Document level: classify a document (e.g., a movie review) based on the overall sentiment expressed by opinion holder into, e.g.: positive, or negative (and neutral). Assumption: Each document focuses on a single object and contains opinions from a single opinion holder: $(o_j, f_{jk}, so_{ijkl}, h_i, t_l)$, where $o_j = f_{jk}$
- Sentence level: idem, but for (subjective) sentences, so these need to be identified first.
- Feature level: sentence/doc-level sentiment analysis can have **mixed** opinions and they do not tell **what** people like/dislike. A positive/negative opinion on an object does not mean that the opinion holder likes/dislikes everything. Better to find opinions on component and/or its attributes. This allows all sorts of analyses.

Sentiment Analysis

Granularity level - feature level (ctd) - Steps:

- Identify and extract object features that have been commented on by an opinion holder (e.g., a reviewer).
- Determine whether the opinions on the features are positive, negative or neutral.
- Group synonym features, e.g. *screen* and *touch screen*.
- Optional: produce a feature-based opinion summary of multiple reviews.

Sentiment Analysis

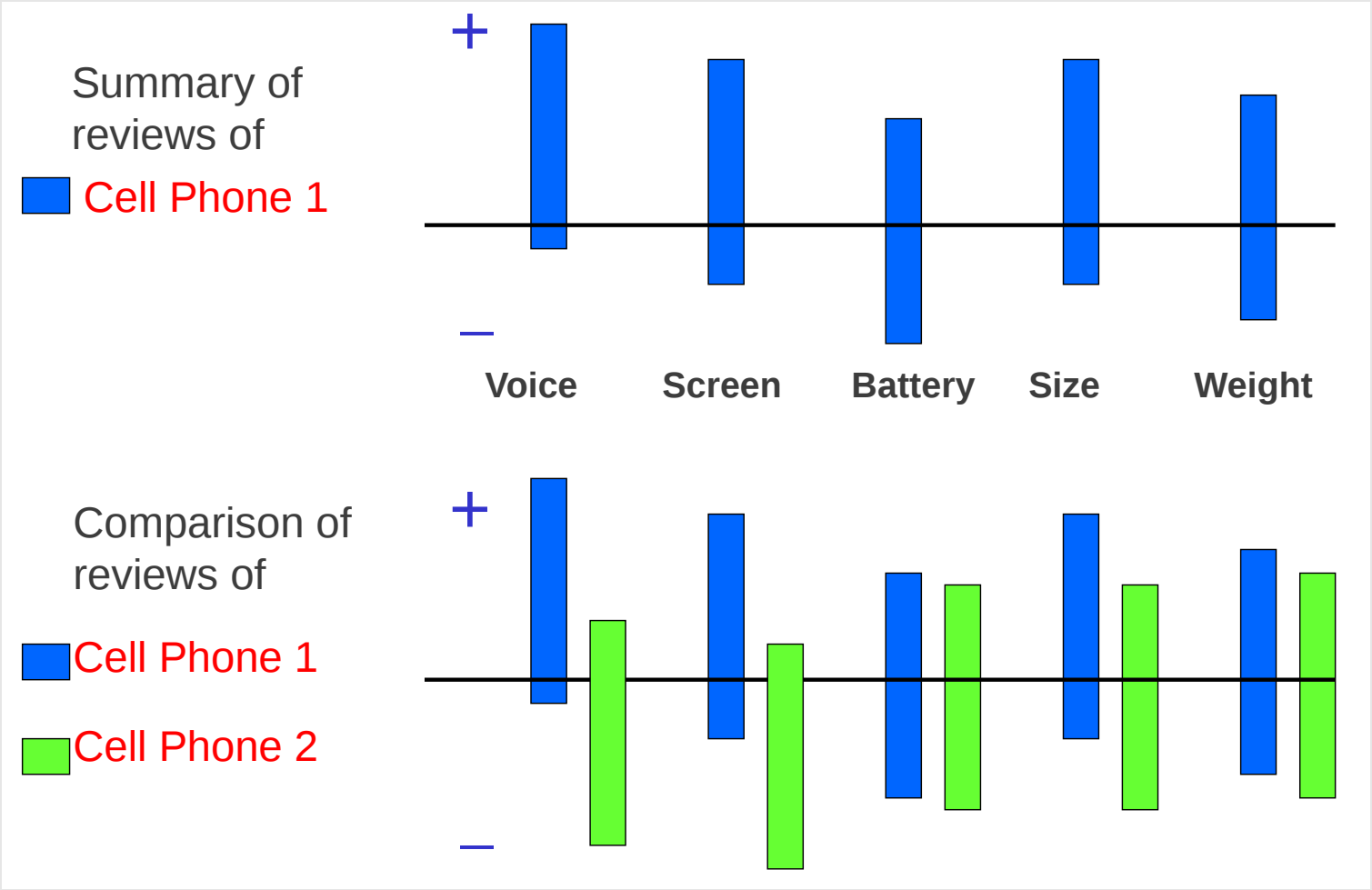
Granularity level - feature level (ctd):

"I bought the new iPhone a few days ago. ..."

Feature Based Summary:

- Feature1: **touch screen**
- Positive:
  - The touch screen was really cool.
  - The touch screen was so easy to use and can do amazing things.
  - ...
- Negative:
  - The screen is easily scratched.
  - I have a lot of difficulty in removing finger marks from the touch screen.
- Feature2: **battery life**
- ...

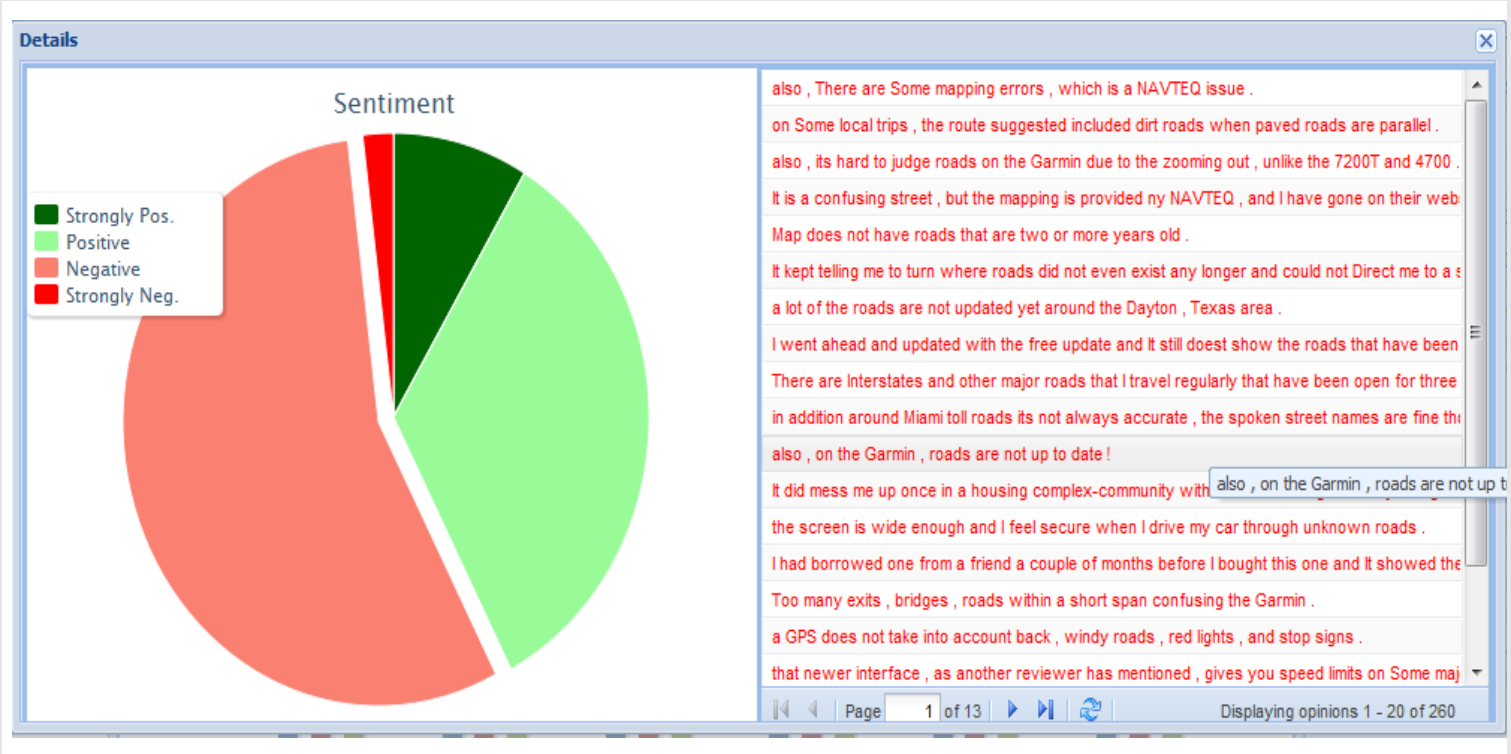
Granularity level - feature level (ctd): Visual Comparison



(Bing Liu)

Sentiment Analysis

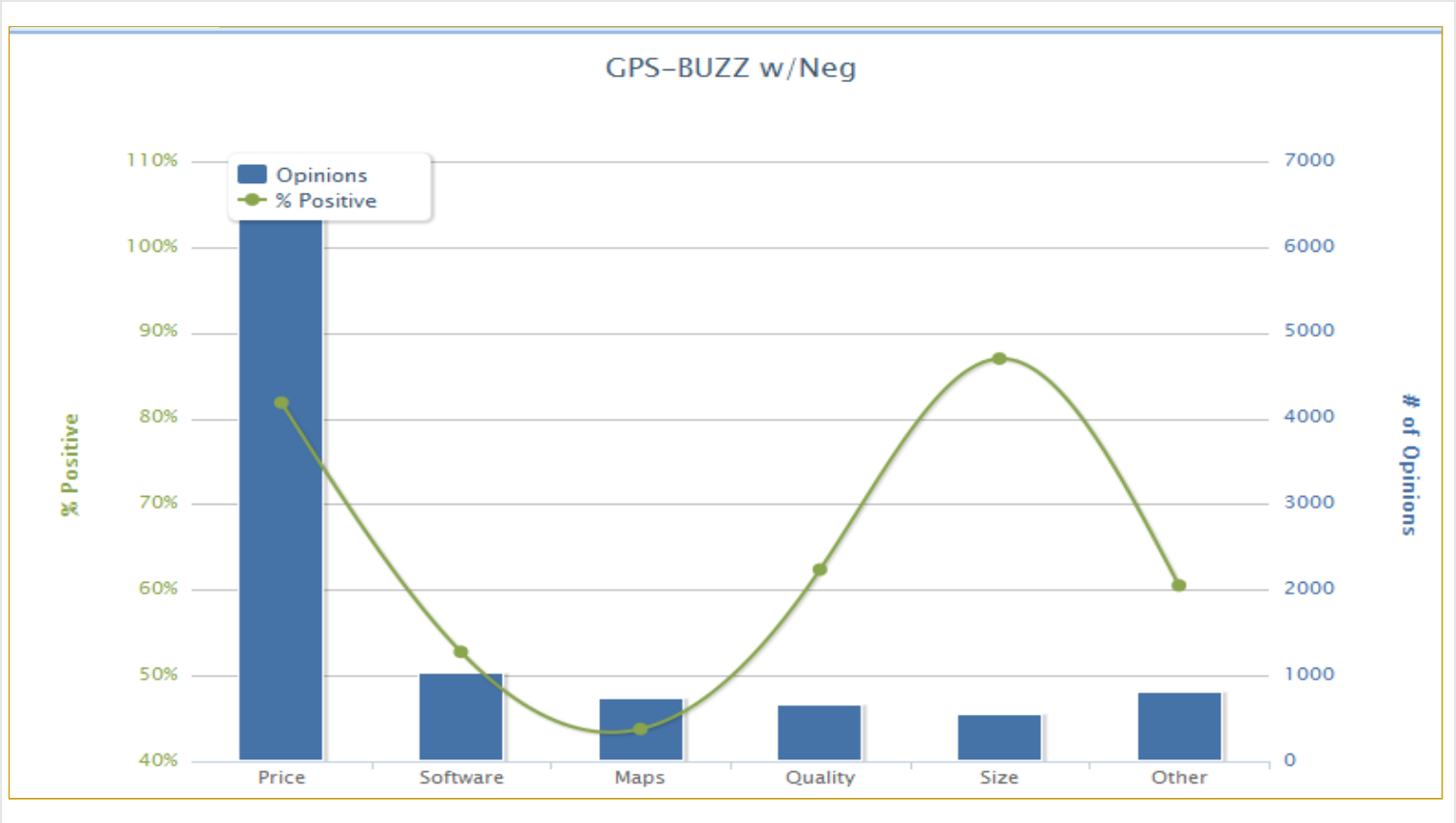
Granularity level - feature level (ctd): Proportion of opinions + examples



(Bing Liu)

Sentiment Analysis

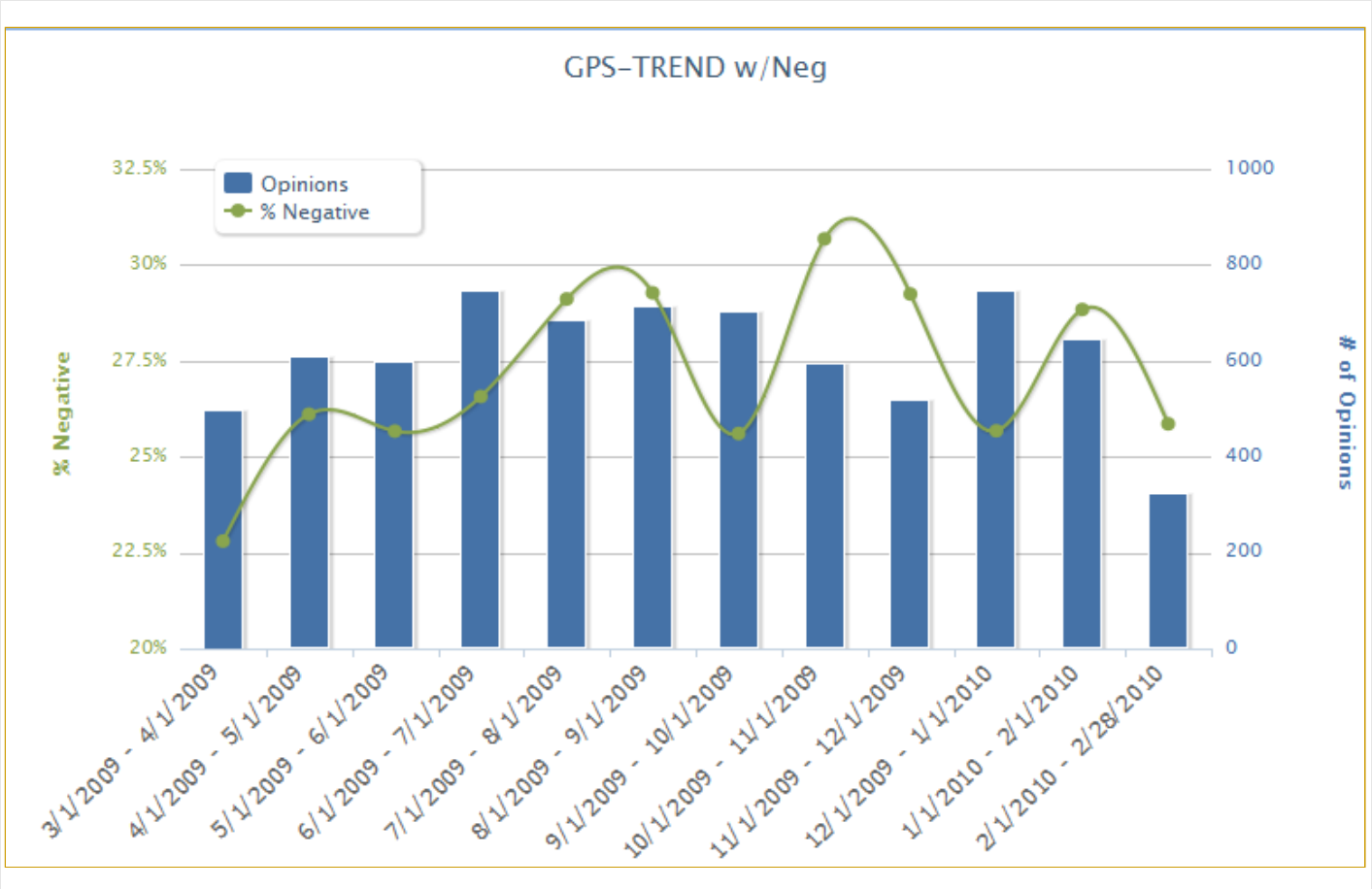
Granularity level - feature level (ctd): Frequency of opinions for a feature



(Bing Liu)

Sentiment Analysis

Granularity level - feature level (ctd): Aggregate opinions over time (trends)



(Bing Liu)

Challenges for Sentiment Analysis

This past Saturday, I bought a Nokia phone and my girlfriend bought a Motorola phone with Bluetooth. We called each other when we got home. The voice on **my** phone was not so clear, worse than my previous phone. The battery life was long. My girlfriend was quite happy with **her** phone. I wanted a phone with good sound quality. So my purchase was a real disappointment. I returned the phone yesterday.

Challenges for Sentiment Analysis

I've seen movies where there was practically no plot besides explosion, explosion, catchphrase, explosion. I've even seen a movie where nothing happens. But White on Rice was new on me: a collection of really wonderful and appealing characters doing completely baffling and uncharacteristic things.

Challenges for Sentiment Analysis

One has to solve a number of language processing problems:
$(o_j, f_{jk}, so_{ijkl}, h_i, t_l)$

- o_j: a target object: Named Entity Recognition
- f_{jk}: a feature of o_j: Information Extraction
- so_{ijkl}: a sentiment about f_{jk}: Sentiment determination
- h_i: an opinion holder: Information (or metadata) Extraction
- t_l: a time: Information (or metadata) Extraction

In addition:

- Co-reference resolution
- Relation extraction
- Synonym match ("voice" = "sound quality")

None of them is a solved problem!

Main components

Identifying target objects

- Named Entity Recognition: well-known tools based on *gazetteers* and simple context rules. E.g.: Paris, BMW and Ford.
  - Need good gazetteers: Web is dynamic, new products appearing everyday.
  - Will not work for objects like names of movies.
- Bootstrap from seed gazetteers: e.g. if know that iPhone 4 is an object, can find out that iPhone 5 is also an object.

Main components

Co-reference (and synonym) resolution

- Important to resolve objects and features.
- E.g.: "I bought a Canon d500 camera yesterday. It looked beautiful. I took a few photos last night. They were amazing". I am happy with the device.

$\rightarrow$

- E.g.: "I bought a Canon d500 camera yesterday. The Canon d500 camera looked beautiful. I took a few photos last night. The photos were amazing". I am happy with the camera.

Extra reading

Bing Liu and Lei Zhang (2012). A survey on opinion mining and sentiment analysis. Kluwer Academic Publishers:
`http://www.cs.uic.edu/~lzhang3/paper/opinion_survey.pdf`