Longitudinal Sales Responses with Online Reviews

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Outline

- Motivation and Background
- Related Work
- Consumer Sentiment Metrics
- Experiments
- Conclusions
Background

Consumers share their experiences on the Web
## Background

They rate in addition to comments/evaluation

<table>
<thead>
<tr>
<th>Rating</th>
<th>Number of Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>★★★★★</td>
<td>26</td>
</tr>
<tr>
<td>★★★★</td>
<td>22</td>
</tr>
<tr>
<td>★★★</td>
<td>16</td>
</tr>
<tr>
<td>★★★</td>
<td>20</td>
</tr>
<tr>
<td>★★</td>
<td>80</td>
</tr>
</tbody>
</table>

![Rating examples](image)
Background:
Ratings and Comments Co-exit

From http://www.expedia.com

A Traveler
4.0 out of 5
Recommends this hotel
Posted Nov 23 2011

“nice casino ok hotel”
Room had some kind of watery/sticky substance on the headboard and walls. Registration desk was very fast and thorough.

Art S from Atlanta, GA
3.0 out of 5
Does not recommend this hotel
Posted Nov 23 2011

“Clearly a Value Decision”
Stayed here because we could get two rooms for 5 days very cheaply, and for that reason this hotel (I can't name the hotel in the review because of inappropriate language) was a great deal. It was an offer we couldn't refuse, honestly. For the price we paid the rooms were certainly tolerable. The area around seemed to teem with sirens through the night, however. Maybe that's just Vegas. The food in the restaurants was very quick and quite good. Staying here in Vegas is exactly like you would expect staying in one would be like. The crowd was the same kind of crowd you might see at an MMA event.
Motivation:

Impact of Comments/Ratings

Consumers usually seek advices from online reviews before purchasing.

– These reviews significantly impact on consumers’ purchasing behaviors.
Problem: Correlation of Comments and Sales

Study how online consumer reviews impact the sales of economic hotels.

– Consider both ratings and comments
– Measure sentiments in comments
– Investigate correlations:
  • sentiments vs sales
  • ratings vs sales
  • sentiments vs ratings
Data Sets

• From a leading travel service provider in China
  – Over 50 million registered members
  – Comprehensive services: hotel booking, flight ticketing, packaged tours and corporate travel management

• Sales data of economic hotels
  – 1901 economic hotels
  – 137,568 booking records from 2006 to 2009
  – Each booking record includes selling price
  – 97,990 pieces of reviews with both ratings (1 ~ 5) and comments.
### TABLE I. A SAMPLE OF CONSUMER REVIEWS

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Rating</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>sanitation</td>
<td>4</td>
<td>The room was clean, shower is very comfortable; in general, the environment and service of this hotel are good. I enjoyed it very much.</td>
</tr>
<tr>
<td>service</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>environment</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td>facilities</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>
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Related Work

• Word-of-mouth (WOM) for movies (Liu, 2006)
  – Used WOM data collected from the Yahoo Movies Web site;
  – Examined the impact of the volume and polarity of reviews on movie sales;

Conclusions

1. WOM activities are most active during a movie’s prerelease and opening week;
2. WOM information offers significant explanatory power for both aggregate and weekly box office revenue;
3. The power comes more from the volume of WOM than from the polarity.
   – This is also confirmed by our study in this paper.
Related Work

Mining and summarizing customer reviews (Hu&Liu)

- Attributes & opinion words appear frequently in noun-adjective pairs
  - We use review pattern & classify attributes into 4 categories
- Identified opinion sentences and polarities
- Summarized all the customer reviews of a product:

  Digital_camera_1:
  Feature: **picture quality**
  Positive: 253
  <individual review sentences>
  Negative: 6
  <individual review sentences>
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Consumer Sentiment Metrics

Sentiments in consumer comments usually imply different feelings of consumers.

The key problem is to quantitatively measure the sentiments in consumer comments.
Review Patterns

Structures frequently used by consumers to express their sentiments in review comments

- e.g., “the service (attribute) is excellent (adjective word)”

- Primary attributes
  - Explicitly listed for rating (basic attributes of a product)
  - 4 for hotel: sanitation, service, environment and facilities

- Associated attributes
  - E.g., “temperature”, “hot water”
  - New attributes automatically extracted from review content
  - Classified and associated to a primary attribute (e.g., facilities).
Review Pattern Extraction

1. Locate seed attribute terms (4 primary attributes);
2. Find opinion word (usually adjective) around each attribute term to validate a review pattern;
3. The review pattern can be utilized to discover further more attributes/opinion-words iteratively and alternatively.
4. Finally, a set of 4-tuples as <attribute, opinion word, pattern, rating> is obtained
An Overall Workflow
(attributes, opinion words and review patterns)

• Review pattern extraction

1. Locate Consumer comments
2. Search Opinion words
   • Good
   • Nice
   • Expensive
3. Add to Review patterns
4. Detect more attributes
5. Add to Opinion words
   • Opinion words
   • Review patterns

Opinion words
Seed attributes
Review patterns
Post-processing:

– Derived attributes will be removed if their occurrences are less than a threshold (e.g., 3);
– The corresponding 4-tuples are also removed;
– Each new associated attribute is labeled with its primary attribute based on classification.
Sentiment Metric of each opinion word ($o$):

$$R(o) = \frac{1}{|\{t \mid o \in t\}|} \sum_{t' \in \{t \mid o \in t\}} r_{t'}(o)$$

where $\{t \mid o \in t\}$ is the set of 4-tuples which contains opinion word $o$ and $r_{t'}(o)$ is the rating in $t'$. The resulting score reflects the comprehensive sentiment when consumers use the opinion word to review product.
Sentiment Metrics of a review comment ($m$):

$$R(m) = \frac{1}{\left| \{x \mid x \in m\} \right|} \sum_{o \in \{x \mid x \in m\}} R(o)$$

which is an aggregative strategy, to measure multiple sentiments, positive or negative sentiments, in one review comment.
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Longitudinal Study of Sentiment & Sales

Schematic diagram of impact examination
h’s Overall Rating and Sentiment in \( t \)

**Overall consumer ratings**

Given a hotel \( h \) and a time span \( t \), the aggregate consumer rating is

\[
R_{h,t} = \frac{1}{|S|} \sum_{s \in S} \left( \frac{1}{4} \sum_{i=1}^{4} r_{s,i} \right)
\]

in which \( S \) is the set of consumer ratings for hotel \( h \) in period \( t \).

**Overall sentiment metric (score)**

\[
T_{h,t} = \frac{1}{|Q_t|} \sum_{m \in Q_t} R(m)
\]

where \( Q_t \) is the set of consumer comments for hotel \( h \) in period \( t \) and \( R(m) \) is the consumer sentiment score.
Experiments

• Dataset 1
  – The hotels with at least 200 reviews are chosen;
  – Results in 127 hotels;
  – Use month as the time interval;
  – 3,213 transactions.

• Dataset 2
  • The hotels with at least 400 reviews are chosen.

• Dataset 3
  • The hotels with at least 600 reviews are chosen.
# Experiments

## TABLE II. Samples of Rating and Sale Transaction

<table>
<thead>
<tr>
<th>Trans ID</th>
<th>Consumer rating</th>
<th>Sentiment rating</th>
<th>Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.0833</td>
<td>3.9232</td>
<td>187</td>
</tr>
<tr>
<td>2</td>
<td>4.0833</td>
<td>3.8038</td>
<td>215</td>
</tr>
<tr>
<td>3</td>
<td>4.0636</td>
<td>3.9718</td>
<td>228</td>
</tr>
<tr>
<td>4</td>
<td>3.7956</td>
<td>3.8190</td>
<td>328</td>
</tr>
<tr>
<td>5</td>
<td>3.8647</td>
<td>3.8002</td>
<td>299</td>
</tr>
<tr>
<td>6</td>
<td>4.0153</td>
<td>3.9353</td>
<td>262</td>
</tr>
<tr>
<td>7</td>
<td>4.0666</td>
<td>3.8462</td>
<td>237</td>
</tr>
<tr>
<td>8</td>
<td>3.7411</td>
<td>3.8465</td>
<td>236</td>
</tr>
<tr>
<td>9</td>
<td>3.1200</td>
<td>3.9301</td>
<td>150</td>
</tr>
<tr>
<td>10</td>
<td>4.0000</td>
<td>3.6001</td>
<td>143</td>
</tr>
</tbody>
</table>
Experiments

Sales changes with the increase of **consumer ratings** on the three datasets
Experiments

Sales changes with the increase of sentiment score on the three datasets
## Experiments

### TABLE III. Final result of correlation analysis

<table>
<thead>
<tr>
<th></th>
<th>dataset1</th>
<th>dataset2</th>
<th>dataset3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>consumer rating</td>
<td>sentiment rating</td>
<td>sales</td>
</tr>
<tr>
<td>consumer rating</td>
<td>1.000</td>
<td>0.448</td>
<td>0.122</td>
</tr>
<tr>
<td>N/A</td>
<td>0.000</td>
<td>0.000</td>
<td>N/A</td>
</tr>
<tr>
<td>0.448</td>
<td>1.000</td>
<td>0.040</td>
<td>0.430</td>
</tr>
<tr>
<td>sentiment rating</td>
<td>0.000</td>
<td>N/A</td>
<td>0.000</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0.122 &gt; 0.040</td>
<td>1.000 &gt; 0.167</td>
<td>1.000 &gt; 0.196</td>
</tr>
</tbody>
</table>
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Conclusions

1. Both consumer ratings and consumer comments have certain influence on hotel sales;

2. Sales has higher correlation with consumer ratings than with sentiment score;

3. There is certain correlation between consumer rating and sentiment, showing their relatedness; but the correlation is far smaller than 1, indicating their inconsistency.
Thanks you!

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