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

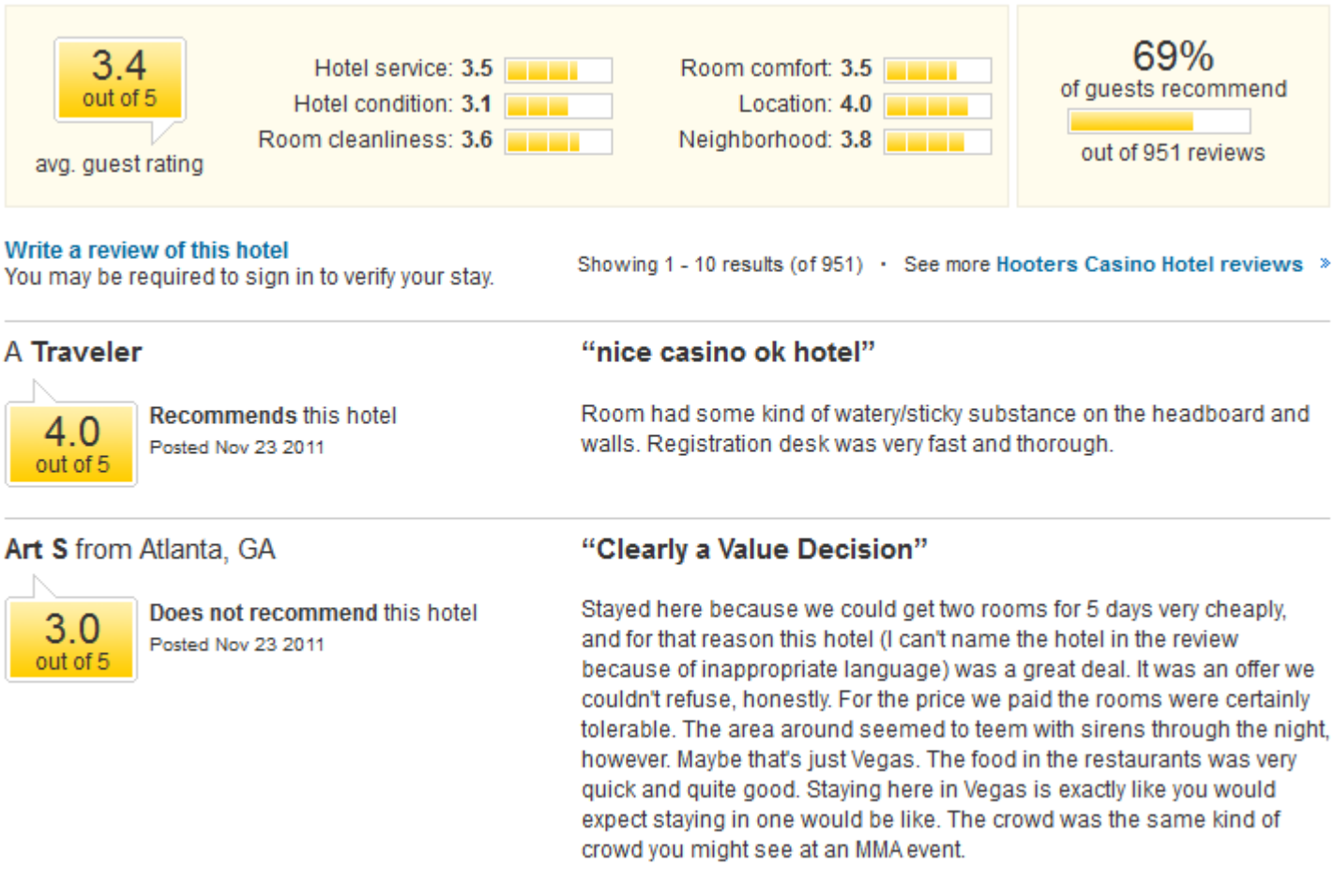
Background

They rate in addition to comments/evaluation

Rating	Number of Users
★★★★★	26
★★★★	22
★★★	16
★★	20
★	80

Background:
Ratings and Comments Co-exit

From http://www.expedia.com



3.4 out of 5
avg. guest rating

Hotel service: 3.5
Hotel condition: 3.1
Room cleanliness: 3.6
Room comfort: 3.5
Location: 4.0
Neighborhood: 3.8

69%
of guests recommend
out of 951 reviews

Write a review of this hotel
You may be required to sign in to verify your stay.

Showing 1 - 10 results (of 951) · See more Hooters Casino Hotel reviews »

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.**

Sample of Consumer Review/Rating

TABLE I. A SAMPLE OF CONSUMER REVIEWS

Attribute	Rating	Comments
sanitation	4	The room was clean, shower is very comfortable; in general, the environment and service of this hotel are good. I enjoyed it very much.
service	3.5	
environment	4.5	
facilities	4	

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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

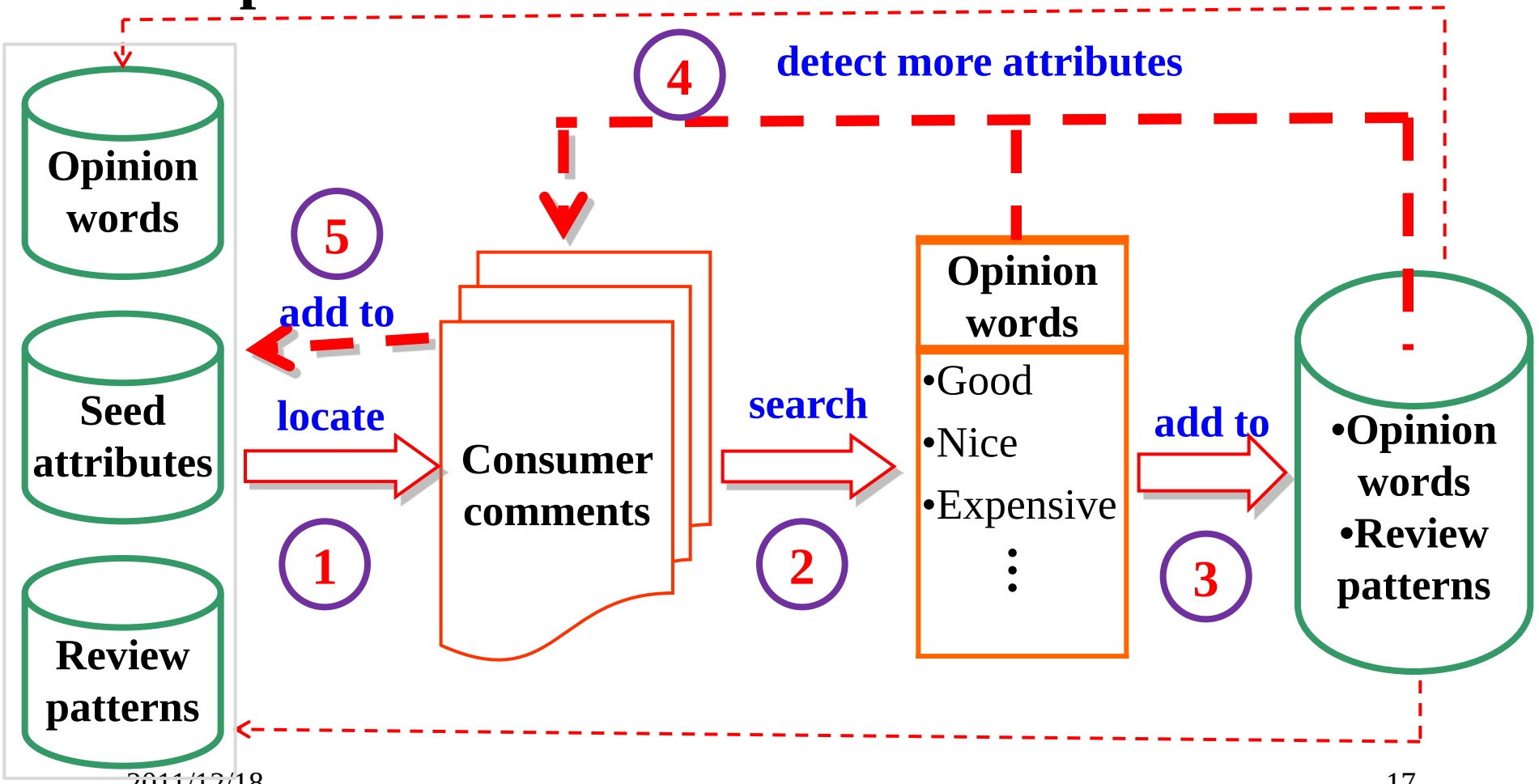
- e.g., "the service (*attribute*) is excellent (*adjective word*)"
- Primary attributes
  - Explicitly listed for rating (basic attributes of a product)
  - 4 for hotel: sanitation, service, environment and facilities
- Associated attributes
  - E.g., "temperature", "hot water"
  - New attributes automatically 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**



Consumer Sentiment Metrics

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.

Consumer Sentiment Metrics

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.

Consumer Sentiment Metrics

Sentiment Metrics of a review comment (*m*):

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

which is an aggregative strategy, to measure multiple sentiments, positive or negative sentiments, in one review comment.

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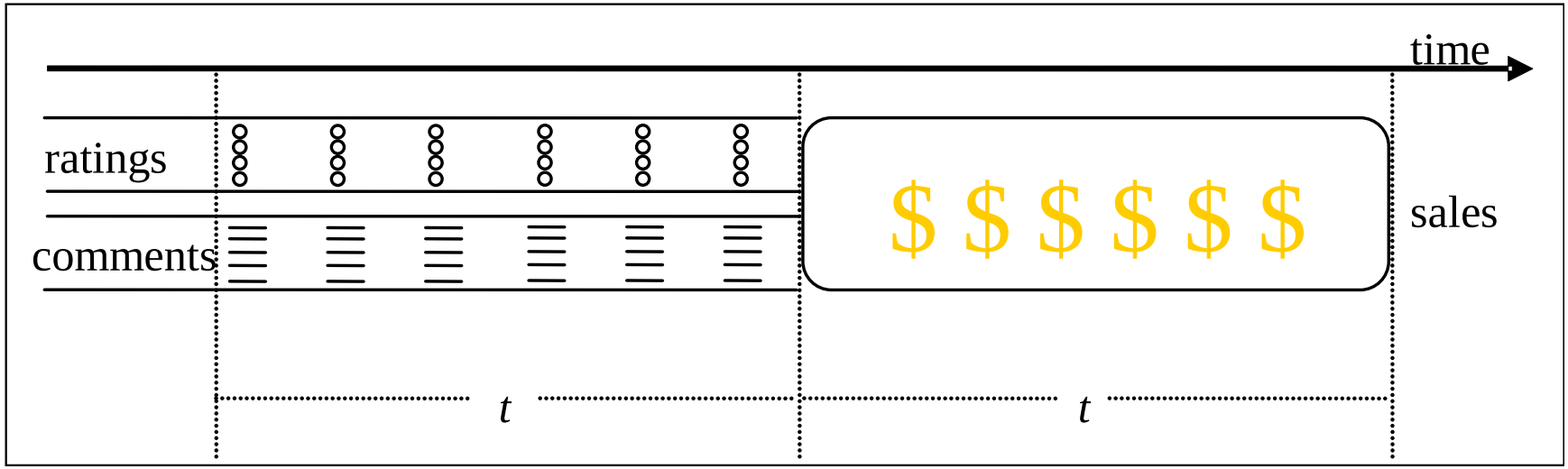
Longitudinal Study of Sentiment & Sales



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

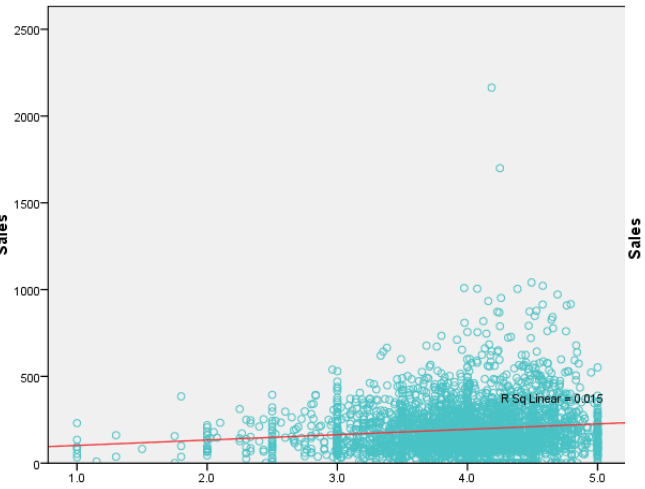
- **Dataset 1**
  - The hotels with at least 200 reviews are chosen;
  - Results in 127 hotels;
  - Use month as the time interval;
  - 3,213 transactions.
- **Dataset 2**
  - The hotels with at least 400 reviews are chosen.
- **Dataset 3**
  - The hotels with at least 600 reviews are chosen.

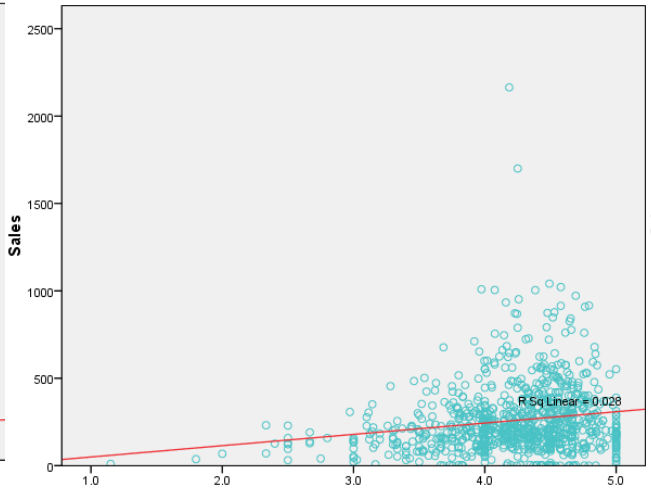
Experiments

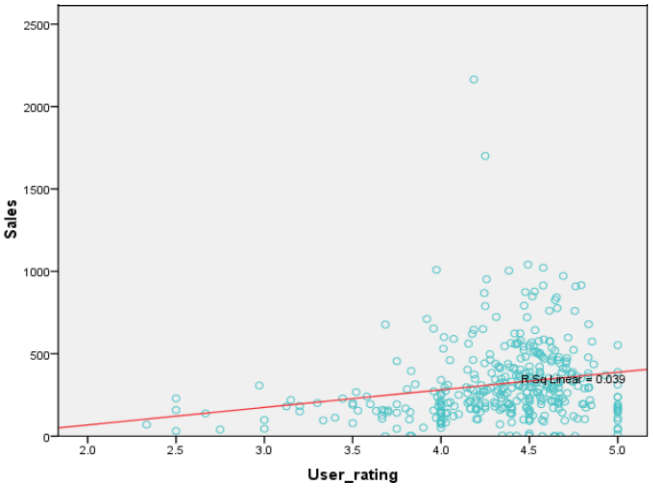
TABLE II. SAMPLES OF RATING AND SALE TRANSACTION

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

Experiments

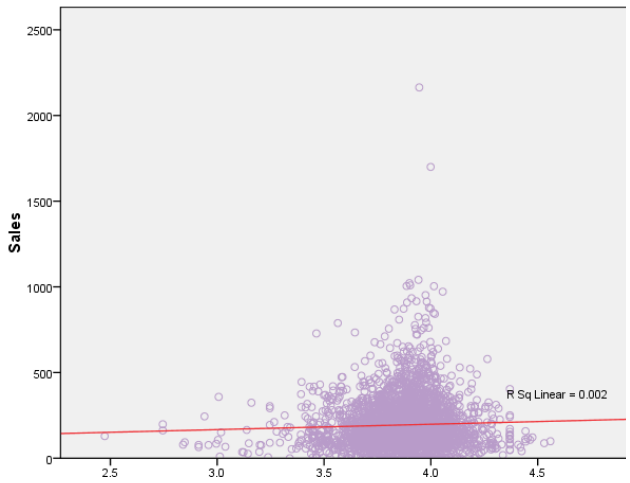


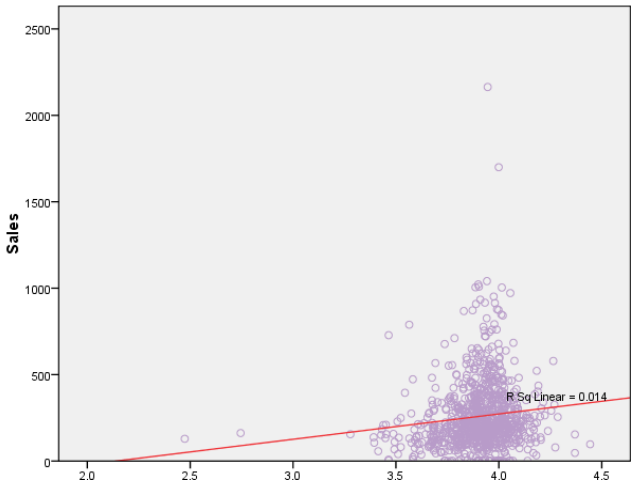


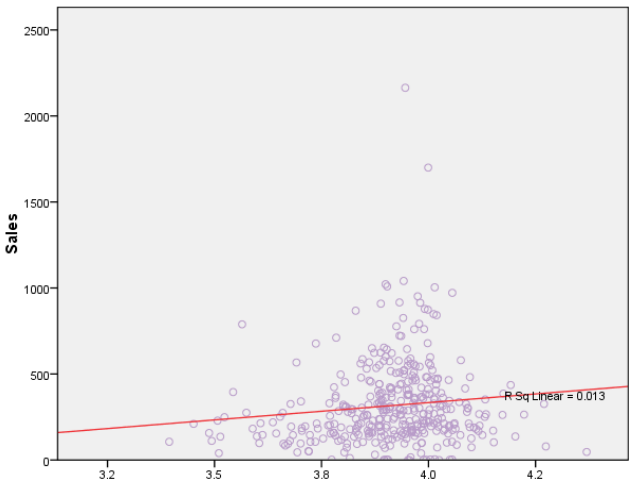


Sales changes with the increase of **consumer ratings** on the three datasets

Experiments







Sales changes with the increase of **sentiment score** on the three datasets

Experiments

TABLE III. FINAL RESULT OF CORRELATION ANALYSIS

		dataset1			dataset2			dataset3		
		consumer rating	sentiment rating	sales	consumer rating	sentiment rating	sales	consumer rating	sentiment rating	sales
consumer rating	Pearson Correlation	1.000	0.448	0.122	1.000	0.430	0.167	1.000	0.376	0.196
	Sig. (2-tailed)	N/A	0.000	0.000	N/A	0.000	0.000	N/A	0.000	0.000
sentiment rating	Pearson Correlation	0.448	1.000	0.040	0.430	1.000	0.118	0.376	1.000	0.115
	Sig. (2-tailed)	0.000	N/A	0.000	0.000	N/A	0.000	0.000	N/A	0.025
sales	Pearson Correlation	0.122	0.040	1.000	0.167	0.118	1.000	0.196	0.115	1.000
	Sig. (2-tailed)	0.000	0.000	N/A	0.000	0.000	N/A	0.000	0.025	N/A

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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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