Overview
Motivation & Terminology
Opinion Mining Work
Overview of OPINE
Product Feature Extraction
Customer Opinion Extraction
Experimental Results
Conclusion and Future Work

Motivation
Reviews abound on the Web
consumer electronics, hotels, etc.
Automatic extraction of customer opinions
can benefit both manufacturers and customers
Other Applications
Automatic analysis of survey information
Automatic analysis of newsgroup posts

Terminology
Reviews contain features and opinions.
Product features include:
Parts the cover of the scanner
Properties the size of the Epson3200
Related Concepts the image from this scanner
Properties & Parts of Related Concepts the image size for the HP610
Product features can be:
Explicit the size is too big
Implicit the scanner is not small

Terminology
Reviews contain features and opinions.
Opinions can be expressed by:
Adjectives noisy scanner
Nouns scanner is a disappointment
Verbs I love this scanner
Adverbs the scanner performs beautifully
Opinions are characterized by polarity (+, -)
and strength (great > good).

Opinion Mining Work
Extract positive/ negative opinion words
Hatzivassiloglou & McKeown’97, Turney’03, etc.
Opinion Mining Work

Extract positive/negative opinion words
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Classify reviews as positive or negative
Turney’02, Pang’02, Kushal’03

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Identify feature-opinion pairs together with the polarity of each opinion
Hu & Liu’04, Hu & Liu’05

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Hu & Liu’04, Hu & Liu’05

OPI NE: High-precision feature-opinion extraction, opinion polarity and strength extraction

The OPI NE System

<table>
<thead>
<tr>
<th>OpinionPhrase</th>
<th>Rank</th>
<th>Polarity</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deafening</td>
<td>1</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Loud</td>
<td>2</td>
<td>-</td>
<td>7</td>
</tr>
<tr>
<td>Silent</td>
<td>3</td>
<td>+</td>
<td>3</td>
</tr>
<tr>
<td>Quiet</td>
<td>4</td>
<td>+</td>
<td>4</td>
</tr>
</tbody>
</table>

Sample OPI NE output in the Hotel domain

The OPI NE System

Input: product class C, reviews R
Output: set of feature-opinion pairs \{(f, o)\}.

\[ R' \rightarrow \text{parseReviews( } R \text{ )} \]

\[ E \rightarrow \text{findExplicitProductFeatures}(R', C) \]

\[ O \rightarrow \text{findOpinions}(R', E) \]

\[ CO \rightarrow \text{clusterOpinions}(O) \]

\[ I \rightarrow \text{findImplicitFeatures}(CO, E) \]

\[ RO \rightarrow \text{solveOpinionRankingCSP}(CO) \]

\[ \{(f, o)\} \rightarrow \text{outputFeatureOpinionPairs}(RO, I \cup E) \]
Explicit Feature Extraction

Given product class C
1. Extract parts and properties of C
   Recursively extract parts and properties of C’s parts and properties, etc.
2. Extract related concepts of C
(Popescu & all, 2004)
   Extract parts and properties of related concepts

Parts and Properties

Extract review noun phrases with frequency f > k as potential meronyms.
Assess candidates using discriminators D derived from patterns P.

Example:
P = \{M\} of C
D0 = \{M\} of scanner
D1 = \{M\} of Epson 3200
PMI(size, \{M\} of scanner) = \text{Hits}(\text{size of scanner})
PMI(size, \{M\} of Epson 3200) = \text{Hits}(\text{size of Epson 3200})

Compute PMI(M, P) = \text{PMI(M, D0)} + \ldots + \text{PMI(M, Dk)}.
Convert PMI(M, P) into binary features for a NB classifier.
Retain meronyms M with p(meronym(M, C)) > t.
Separate parts from properties using WordNet and Web information.

Opinion Extraction

Given feature f and sentence s containing f
Extract phrases whose head modifies head(f).

Example:
f = resolution s = … great resolution …
f = scanner s = … scanner is white …
f = scanner s = … scanner is a horror …
f = scanner s = I hate this scanner.
f = scanner s = The scanner works well.

OPINE then determines the polarity of each potential opinion phrase.

Polarity Extraction

Each potential opinion op has a semantic orientation label L(op): +, - , |.

Initial SO Label Assignment
OPINE derives an initial label for each potential opinion:
- SO(op) = PMI(op, good) - PMI(op, bad).
- If SO(op) < t or Hits(op) < t2, L(op) = ”|” (neutral).
- Else if SO(op) > 0, L(op) = “+”.
- Else L(op) = “-”.

Final SO Label Assignment
OPINE uses constraints to derive a final set of labels:
WordNet constraints
Conjunction/disjunction constraints
- attractive, but expensive
Iteration i:
L_i(op) = f(L_{i-1}(op), L_{i-1}(op_0), \ldots, L_{i-1}(op_k))
Termination Condition:
Labels remain constant over consecutive iterations.
Implicit Properties

Adjectival opinions refer to implicit or explicit properties.
Example: slow driver speed, slow driver

OPINE extracts properties corresponding to adjectives and uses them to derive implicit features.

Clarity: intuitive understandable clear straightforward
Noise: silent noisy quiet loud deafening
Price: cheap inexpensive affordable expensive

Clustering Adjectives

Generate initial clusters using WordNet syn/antonyms.
Clusters Ai and Aj are merged if there exist multiple elements ai, aj such that ai is similar to aj with respect to WordNet:
similar(ai, aj): derived(ai, Cl, att(C, aj)),
similar(ai, aj): att(C1, ai), att(C2, aj), subclass(C1, C2), etc.

For each cluster Ai,
OPINE uses queries such as
[a, b, and X] [a, even X] [a, or even X], etc.
to extract additional related adjectives a′ from the Web.
If multiple a′ are elements of cluster A′,
Ai + Ar = A′

Implicit Features:
the interface is intuitive clarity(interface): intuitive straightforward interface clarity(interface): straightforward

Rank Opinion Phrases

Initial opinion phrase ranking
Derived from the magnitude of the SO scores:
|SO(great)| > |SO(good)|: great > good

Final opinion phrase ranking
Given cluster A
Use patterns such as
[a, even X] [a, just not a] [a, but not a], etc.
to derive set S of constraints on relative opinion strength
C = «silent» > «quiet», «deafening» > «loud»
Augment S with antonymy/synonymy constraints
Solve CSP to find final opinion phrase ranking

HotelNoise: deafening > loud > silent > quiet

Opinion Sentences

Opinion sentences are sentences containing at least one product feature and at least one corresponding opinion.

Determining Opinion Sentence Polarity
Determine the average strength s of sentence opinions op
If s > t,
Sentence polarity is indicated by the sign of s
Else
Sentence polarity is that of the previous sentence

Experimental Results

Datasets: 7 product classes, 1621 reviews
5 product classes from Hu&Liu’04
2 additional classes: Hotels, Scanners

Experiments:
Feature Extraction: Hu&Liu’04 vs. OPINE
Opinion Sentences: Hu&Liu’04 vs. OPINE
Opinion Phrase Extraction & Rankings: OPINE

OPINE vs. Hu&Liu

Feature Extraction
OPINE improves precision by 22% with a 3% loss in recall.
Increased precision is due to Web-based feature assessment.

Opinion Sentence Extraction
OPINE outperforms Hu & Liu on opinion sentence extraction:
22% higher precision, 11% higher recall
OPINE outperforms Hu & Liu on sentence polarity extraction:
8% higher accuracy
OPINE handles adjectives, noun, verb, adverb opinions and limited pronoun resolution. OPINE also uses a more restrictive definition of opinion sentence than Hu & Liu.
OPINE Experiments

Extracting opinion phrases for a given feature:
P = 86%, R = 82%
Parser errors reduce precision
Some neutral adjectives can acquire a pos/ neg polarity in context - these adjectives can lead to reduced precision/ recall

Opinion Phrase Polarity Extraction
P = 91%
Precision is reduced by adjectives which can acquire either a positive or a negative connotation: visible

Ranking Opinion Phrases Based on Strength
P = 93%

Conclusion & Future Work

OPINE is a high-precision opinion mining system which extracts fine-grained features and associated opinions from reviews.
OPINE successfully uses the Web in order to improve precision.

Future Work
Use OPINE’s output to generate review summaries at different levels of granularity.
Augment the opinion vocabulary.
Allow comparisons of different products with respect to a given feature.