

# Opinion Mining

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# Outline

- Introduction
  - Opinion Mining
  - Linguistic Perspective
  - Application
- Opinion Mining
  - Abstraction
  - Linguistic Resource of OM
  - Document, Sentence, Clause Level Sentiment Analysis
  - Feature-based Opinion Mining and Summarization
  - Comparative Sentence and Relation Extraction
- Conclusion
  - Resource
  - Challenges

## Introduction – Opinion Mining

- **Wikipedia**

Sentiment analysis or opinion mining refers to a broad area of natural language processing, computational linguistics and text mining.

Generally speaking, it aims to determine the attitude of a speaker or a writer with respect to some topic. The attitude may be their judgment or evaluation, their affective state or the intended emotional communication.

## Introduction – Opinion Mining

- A recent discipline at the crossroads of information retrieval, text mining and computational linguistics which tries to detect the opinions expressed in the natural language texts.
- **Opinion Extraction** is a specified method of information extraction, delivering inputs for opinion mining
- **Sentiment analysis** and **sentiment classification** are sub-areas of opinion extraction and opinion mining

## Introduction – Linguistic Phenomena [Polanyi & Zaenen, 2006, TA van Dijk, 1995]

- Contextual Valence Shifters
  - Sentence Based Contextual Valence Shifters
    - *John is successful at tennis.*
    - *John is **never** successful at tennis.*
  - Modals
    - *Mary is a **terrible** person. She is **mean** to her dogs.*
    - *If Mary were a **terrible** person, she **would** be **mean** to her dogs.*
    - *Mary is a terrible person because she is mean to her dogs.*
  - Presuppositional Items
    - *It is **sufficient**.*
    - *It is **barely sufficient**.*
    - *It **would be nice** if we could have the curved shape.*

## Introduction – Linguistic Phenomena (cont.)

- Contextual Valence Shifters
  - Tense
    - *This is my favorable car.*
    - *This was my favorable car.*
  - Collocation
    - *It is expensive.* (about prize)
    - *It looks expensive.* (about appearance)
  - Irony
    - *The very brilliant organizer failed to solve the problem.*
    - *Terrorists deserve no mercy!*

## Introduction – Linguistic Phenomena (cont.)

- Discourse Based Contextual Valence Shifters
  - Connectors
    - *Although* Boris is brilliant at math, he is a horrible teacher.
  - Discourse Structure
    - The 7 Series is a large, *well-furnished luxury sedan*. *A midcycle freshening* brought revised styling, *a 4.8-liter, 360-hp V8*, and a new name: the 750i. *The six-speed automatic* shifts smoothly.
  - Multi-entity Evaluation
    - *Coffee is expensive, but Tea is cheap.*
  - Comparative
    - *In market capital, Intel is way ahead of AMD.*

## Introduction – Linguistic Phenomena (cont.)

- Reported Speech
  - E.g. *Mary was a slob.* Vs. *John said that Mary was a slob.*
- Subtopics
  - E.g. The **economic situation** is **more than satisfactory**. The leading indicators show a **rosy** picture. When one looks at the **human rights picture**, one is struck by the increase in arbitrary arrests, by needless persecution of helpless citizens and increase of police brutality.
- Genre Constraints
  - E.g. This film should be **brilliant**. The characters are **appealing**. Stallone plays a happy, wonderful man. His sweet wife is beautiful and adores him. He has a fascinating gift for living life fully. It sounds like a great story, **however, the film is a failure**.



## Introduction – Applications [Liu, 2007]

- Market Intelligence: product, event and service benchmarking
  - Consumer opinion summarization
    - E.g. Which groups among our customers are unsatisfied? Why?
  - Public opinion identification and direction
    - E.g. What are the opinions of the Americans about the European style cars?
  - Recommendation
    - E.g. New Beetles is the favorite car of the young ladies.
  - Consultants
  - Virtual sale experts
  - Marketing predication
- Opinion retrieval / search
  - Opinion-oriented search engine
  - Opinion-based question answering
    - E.g. What is the general opinion on the proposed tax reform?
  - Sentiment-enhanced machine translation

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## Opinion Mining – Abstraction [Liu, Web Data Mining book 2007]

- **Opinion holder**
  - The person or organization that holds a specific opinion on a particular object
- **Object**
  - A product, person, event, organization, topic or even an opinion
- **Opinion**
  - A view, attitude, or appraisal on an object from an opinion holder. An opinion contains often sentiment words which can be classified into polarities such as positive, negative, and neutral.

E.g. *John* said that *Mary* was *a slob*.

E.g. *Gas mileage* of *VW Golf* is great !

## Opinion Mining – Model of a review [Liu, Web Data Mining book 2007]

- An object  $O$  is represented with a finite set of features,  $F = \{f_1, f_2, \dots, f_n\}$ 
  - Each feature  $f_i$  in  $F$  can be expressed with a finite set of words or phrases  $W_i$ , E.g. *V-6, V-8* → *Engine*
  - Another word, we have a set of corresponding synonym sets  $W = \{W_1, W_2, \dots, W_n\}$  for the features
- Model of a review: An opinion holder  $j$  comments on a subset of the features  $S_j \subseteq F$  of object  $O$ 
  - For each feature  $f_k \in S_j$  that  $j$  comments on, he/ she
    - Chooses a word or phrase from  $W_k$  to describe the feature, and
    - Expresses a positive, negative or neutral opinion on  $f_k$
  - E.g. *Expensive design & Expensive prize*

## OM – Research topics

- Development of linguistic resources for OM
  - Automatically build lexicons of subjective terms
- At the document/sentence level
  - Simple opinion extraction (a holder, an object, an opinion)
  - Subjective / objective classification
  - Sentiment classification: positive, negative and neutral
- At the feature level
  - Identify and extract commented features
  - Group feature synonyms
  - Determine the sentiments towards these features
- Comparative opinion mining
  - Identify comparative sentences
  - Extract comparative relations from these sentences



## OM – Linguistic Resource of OM [Esuli, 2006]

- Linguistic resource of OM are **opinion words or phrases** which are used as instruments for sentiment analysis. It also called polar words, opinion bearing words, subjective element, etc.
- Research work on this topic deal with **three main tasks**:
  - Determining term **orientation**, as in deciding if a given Subjective term has a Positive or a Negative slant
  - Determining term **subjectivity**, as in deciding whether a given term has a Subjective or an Objective (i.e. neutral, or factual) nature.
  - Determining the **strength** of term attitude (either orientation or subjectivity), as in attributing to terms (real-valued) degrees of positivity or negativity.
- Example
  - Positive terms: *good, excellent, best*
  - Negative terms: *bad, wrong, worst*
  - Objective terms: *vertical, yellow, liquid*

## Orientation of terms [Esuli, 2006]

### The problem:

Determining if a **subjective term** has a **Positive** or a **Negative** orientation.

[Hatzivassiloglou and McKeown, 1997]

Hypothesis: *adjectives* in **and** conjunctions usually have similar orientation, though **but** is used with opposite orientation.

### Example (conjunction of adjectives)

- ① The tax proposal was *simple and well received...*
- ② The tax proposal was *simplistic but well received...*
- ③ \* The tax proposal was *simplistic and well received...*

Method: a **weighted graph of similarity of orientation** is defined by analyzing **conjunctions** of adjectives in unprocessed text, then a **minimum-cut** method is applied to the graph.

## Orientation of terms [Esuli, 2006]

*[Esuli and Sebastiani, 2005]*

Hypothesis: terms with similar orientation have similar glosses.

### Example (glosses for terms with similar orientation)

good: *“that which is pleasing or valuable or useful”*;  
*“agreeable or pleasing”*.

beautiful: *“aesthetically pleasing”*.

pretty: *“pleasing by delicacy or grace; not imposing”*.

Each term is represented by its **gloss**.

A binary classifier is learned, in a **semi-supervised** process, using the glosses of the Positive and Negative terms in the training set.



## Orientation of terms [Esuli, 2006]

[Turney and Littman, 2003]

Hypothesis: terms with similar orientation tend to co-occur in documents.

The *Semantic Orientation* (SO) of a term is estimated by combining a **pointwise mutual information** (PMI) measure of the term against some *paradigmatic terms*.

Pos = {good, nice, excellent, positive, fortunate, correct, superior}

Neg = {bad, nasty, poor, negative, unfortunate, wrong, inferior}

PMI is measured using the number of results returned by the AltaVista search engine.

$$PMI(t, t_i) = \log \frac{\#("t \text{ NEAR } t_i")}{\#("t")\#("t_i")}$$

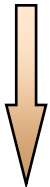
$$SO(t) = \sum_{t_i \in Pos} PMI(t, t_i) - \sum_{t_i \in Neg} PMI(t, t_i)$$

## OM – Polarity acquisition of lexicons

- Application:
  - Naive solution to achieve prior polarities
- Problem:
  - Mixture of subjective & objective words
    - E.g. *long* & *excellent*
  - Conflict
    - E.g. Nice and Nasty ( the first hit from Google for “Nice and \*”)
  - Context dependent
    - E.g. It looks cheap. It is cheap.
    - E.g. It is expensive. It looks expensive.

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## OM – Document Level Sentiment Analysis

- Unsupervised review classification
  - Turyney, 2003
- Sentiment classification using machine learning methods
  - Pang et al., 2002, Pang and Lee, 2004, Whitelaw et al., 2005
- Review classification by scoring features
  - Dave, Lawrence and Pennock, 2005



## OM – Document-level Sentiment Classification

- Motivation: Determining the overall sentiment properties of a text
- Advantage:
  - Coarse-grained Analysis
  - Detection of a general sentiment trend of a document
- Problem:
  - Different polarities, topics and opinion holders in one document, e.g.

This film should be **brilliant**. The characters are **appealing**. Stallone plays a **happy, wonderful** man. His **sweet** wife is **beautiful** and **adores** him. He has a **fascinating** gift for living life fully. It sounds like a **great** story, **however, the film is a failure.**

## Unsupervised review classification

- Hypothesis: the orientation of the whole document is the sum of the orientation of all its parts

- Three steps

- POS Tagging and Two consecutive word extraction (e.g. JJ NN)
- Semantic orientation estimation (AltaVisata near operator)

- Pointwise mutual information

$$PMI(word_1, word_2) = \log_2 \left( \frac{P(word_1 \wedge word_2)}{P(word_1)P(word_2)} \right)$$

- Semantic orientation

$$SO(\text{phrase}) = PMI(\text{phrase}, \text{“excellent”}) - PMI(\text{phrase}, \text{“poor”})$$

- Average SO Computation of all phrases
  - The review is recommended if average SO is positive, not recommended otherwise

- The average accuracy on 410 reviews is 74%, ranging from 84% for automobile reviews to 66% for movie reviews

## Others methods

- [Pang et al., 2002]
  - Apply some standard supervised automatic text classification methods to classify orientation of movie reviews
    - Learners: Naive Bayes, MaxEnt, SVM
    - Features: unigrams, bigrams, adjective, POS, position
    - Preprocessing: negation propagation
    - Representation: binary, frequency
  - 82.9% accuracy, on a 10-fold cross validation experiments on 1,400 movie reviews (best from SVM, unigrams, binary)
- [Pang and Lee, 2004]
  - A sentence subjectivity classifier is applied, as preprocessing, to reviews, to filter out Objective sentences.
  - Accuracy on movie reviews classification raises to 86.4%
- [Whitelaw et al. 2005]
  - Appraisal features are added to the Movie Review Corpus, which obtained a 90.2% classification accuracy.

## OM – Sentence-level Sentiment Classification

- Advantage:
  - Even though the analysis is still coarse, it is more specific than document-level analysis
  - The results can be reused as input for document-level classification
- Problem:
  - Multiple sentiment expressions with different polarities, e.g.

*The very **brilliant** organizer **failed** to solve the problem.*



## OM – Sentence Level Sentiment Analysis (cont.)

- [Riloff and Wiebe, 2003]: subjective / objective classification
  - Taking advantages of Information Extraction techniques
  - Manually collected opinion words + AutoSlog-TS

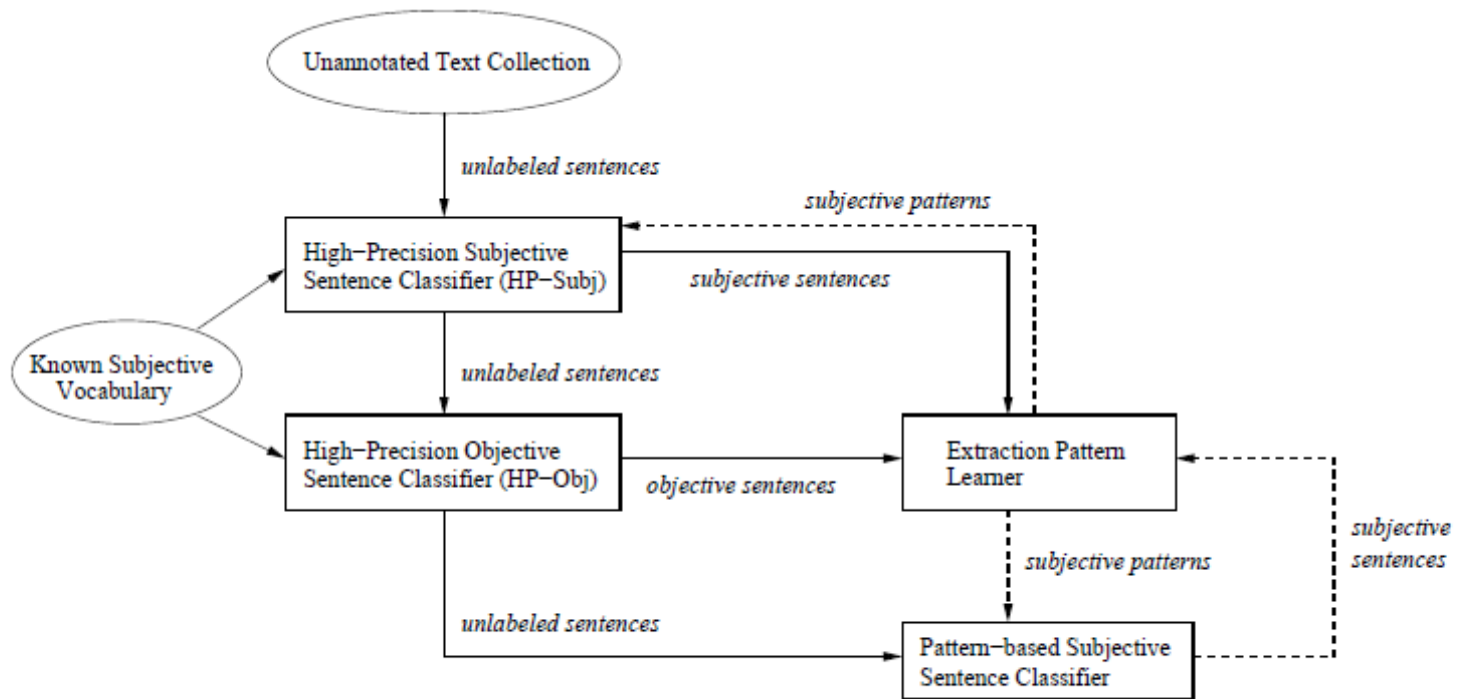


Figure 1: Bootstrapping Process

<subject> passive-vp  
<subject> active-vp  
<subject> active-vp dobj  
<subject> active-vp infinitive  
<subject> passive-vp infinitive  
<subject> auxiliary dobj

*<subj> was satisfied*  
*<subj> complained*  
*<subj> dealt blow*  
*<subj> appears to be*  
*<subj> was thought to be*  
*<subj> has position*

---

active-vp <dobj>  
infinitive <dobj>  
active-vp infinitive <dobj>  
passive-vp infinitive <dobj>  
subject auxiliary <dobj>

*endorsed <dobj>*  
*to condemn <dobj>*  
*get to know <dobj>*  
*was meant to show <dobj>*  
*fact is <dobj>*

---

passive-vp prep <np>  
active-vp prep <np>  
infinitive prep <np>  
noun prep <np>

*opinion on <np>*  
*agrees with <np>*  
*was worried about <np>*  
*to resort to <np>*

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  - Identify and extract commented features
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# OM – Feature-based OM and Summarization [Hu and Liu, 2004]

**GREAT Camera.**, Jun 3, 2004

Reviewer: **jprice174** from Atlanta, Ga.

I did a lot of research last year before I bought this camera... It kinda hurt to leave behind my beloved nikon 35mm SLR, but I was going to Italy, and I needed something smaller, and digital.

The **pictures** coming out of this camera are amazing. The 'auto' feature takes great pictures most of the time. And with digital, you're not wasting film if the picture doesn't come out. ...

**Feature1: picture**

Positive: 12

- The **pictures** coming out of this camera are amazing.
- Overall this is a good camera with a really good **picture** clarity.

...

Negative: 2

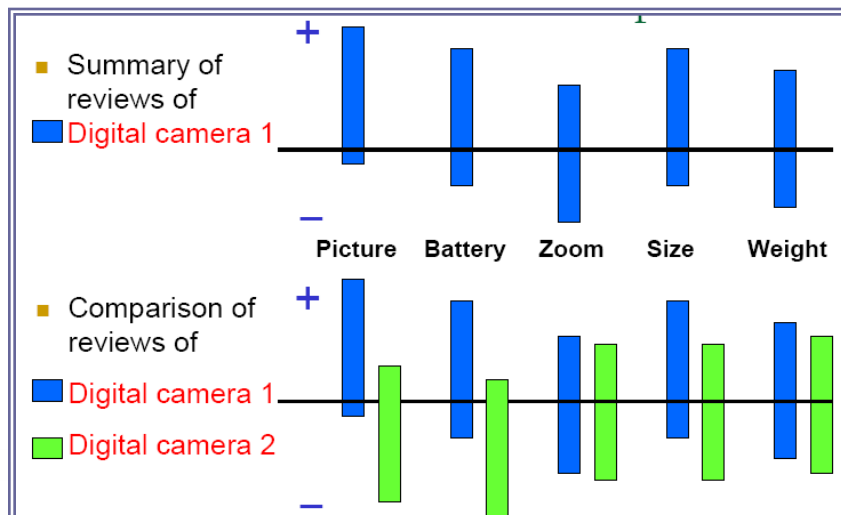
- The **pictures** come out hazy if your hands shake even for a moment during the entire process of taking a picture.
- Focusing on a display rack about 20 feet away in a brightly lit room during day time, **pictures** produced by this camera were blurry and in a shade of orange.

## Prior & contextual SO

- *E.g. Hotel Review:*
  - hot water
  - hot room
- *E.g. Car Review*
  - looks expensive
  - Is expensive

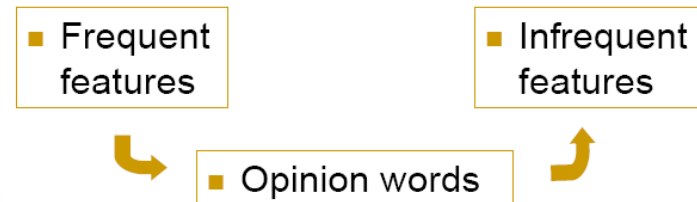
## Feature extraction:

- Explicit & Implicit
  - E.g. great photos <photo>
  - E.g. small to keep <size>
- Frequent & Infrequent



## Featured-based – Feature Extraction

- Frequent & Infrequent features
  - Frequent feature: Label sequential rules
    - Annotation
      - “Included memory is stingy”
      - $\langle \{ \text{included, VB} \} \{ \$feature, \text{NN} \} \{ \text{is, VB} \} \{ \text{stingy, JJ} \} \rangle$
    - Learned LSRs
      - $\langle \{ \text{easy, JJ} \} \{ \text{to} \} \{ *, \text{VB} \} \rangle \rightarrow \langle \{ \text{easy, JJ} \} \{ \text{to} \} \{ \$feature, \text{VB} \} \rangle$
    - Feature extraction
      - The word that matches \$feature is extracted
  - Infrequent feature
    - Observation: the same *opinion word* can be used to describe different features and objects
      - E.g. The pictures (high-freq) are absolutely amazing.
      - E.g. The software (low-freq) that comes with it is amazing.



## Featured-based – Group Feature Synonyms


- Identify part-of relationship [Popescu and Etzioni, 2005]
  - Each noun phrase is given a PMI score with part discriminators (e.g. of scanner, scanner has) associated with the product class, (e.g. a scanner class)
- Carenini et al., 2005 is based on similarity metrics
  - The system merges each discovered feature to a feature node in the pre-set taxonomy
  - The similarity metrics are defined based on string similarity, synonyms and other distances measured using WordNet

Camera	Image
Lens	Image Type
Digital Zoom	TIFF
Optical Zoom	JPEG
...	...
Editing/Viewing	Resolution
Viewfinder	Effective Pixels
...	Aspect Ratio
Flash	...
...	

## Feature Extraction and Group

- Advantage:
  - Precise sentiment analysis about explicit features
- Problems:
  - Multiple relations
    - *Gas Mileage of VW Golf is great.*
      - *Entity: VW Golf*
      - *Attribute: Gas Mileage*
  - Domain knowledge intensive:
    - *V12 8000CC is pretty powerful. <automobile engine version>*
    - *V6 4000CC is not a real good engine.*
  - WordNet is too general

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  - Subjective / objective classification
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-  **Comparative opinion mining**
  - Identify comparative sentences
  - Extract comparative relations from these sentences





## Featured-based Sentiment Orientation [Popescu and Etzioni, 2005]

- Contextual Semantic Orientation
  - <word, SO>, <word, feature, SO>, <word, feature, sentence, SO>
    - E.g. **SEN**: "I am not happy with this sluggish driver."
    - <sluggish, ?>, <sluggish, driver, ?>, <sluggish, driver, SEN, ?>
- Relaxation labeling: sentiment assignment to words satisfying local constraints.
  - *Constraints*:
    - conjunctions, disjunctions, syntactic dependency rule, morphological relationships, WordNet-supplied synonymy and antonymy, etc.
  - *Neighborhood*: a set of words connected the word through constraints.
    - E.g. "hot(?) room and broken(-) fan" → hot(-)

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# OM – Comparative Sentence and Relation Extraction

[Jinal and Liu, SIGIR-2006]

- Morphological and syntactic properties
  - Comparative sentences use morphemes like
    - *More/most, -er/-est, less/least, than and as*
  - Other cases
    - Preferring
      - *E.g. I prefer Intel to AMD.*
    - Non-comparatives with comparative words
      - *E.g. In the context of speed, faster means better.*
- Gradable
  - Non-Equal Gradable: greater or less
    - *E.g. Optics of camera A is better than that of camera B.*
  - Equative
    - *E.g. Camera A and camera B both come in 7MP.*
  - Superlative
    - *E.g. Camera A is the cheapest camera available in market.*
- Non-gradable
  - *E.g. Object A has feature F, but object B does not have.*

## OM – Comparative Sentence and Relation Extraction

- Definition: A gradable comparative relation captures the essence of a gradable comparative sentence and is represented with the following:

*(relation word, features, entity S1, entity S2, type)*

- Relation word: The keyword used to expressed a comparative relation in a sentence. *E.g. better, ahead, most, better than*
  - Features: a set of features being compared
  - Entity S1 and Entity S2: sets of entities being compared
  - Type: non-equal gradable, equative or superlative
- Example
    - *Car X has better controls than car Y.*
      - (better, controls, car X, car Y, non-equal-gradable)
    - *Car X and car Y have equal mileage.*
      - (equal, mileage, car X, car Y, equative)
    - *Car X is cheaper than both car Y and car X.*
      - (cheaper, null, car X, car Y car Z, non-equal-gradable)
    - *Company X produces a variety of cars, but still best cars come from company Y.*
      - (best, cars, company Y, null, superlative)

# Identify comparative sentences

- Extract sentences which contain at least a keyword
  - 83 keywords
    - Words with POS tags: JJR, JJS, RBR, RBS
    - Exceptions:
      - More, less, most and least
      - Indicative words: Best, exceed, ahead, etc
      - Phrases: in the lead, on par with, etc
- Use a NB classifier : comparative & non-comparative
  - Attribute: class sequential rules (CSRs)
    - 13 manual rules
      - Whereas/IN, but/CC, however/RB, while/IN, though/IN, etc
  - E.g. This camera has significantly more noise at ISO 100 than the Nikon 4500.
    - $\langle \{ \$entityS1, NN \} \{ has / VBZ \} \{ * \} \{ more / JJB \} \rangle \rightarrow comparative$

## Extract comparative relations [Jindal and Liu, AAAI-2006]

- Classify comparative sentences into: non-equal gradable, equative, and superlative
  - SVM + keywords
  - If the sentence has a particular keyword in the attribute set, the corresponding value is 1, and 0 otherwise
- Extraction of relation items
  - Extraction of features, entities and relation keywords
    - (*relation word, features, entity S1, entity S2, type*)
  - Assumption:
    - There is only one relation in a sequence
    - Features are nouns
- Not all comparison are evaluations.
  - *E.g. Cellphone X has Bluetooth, but cellphone Y does not have.*

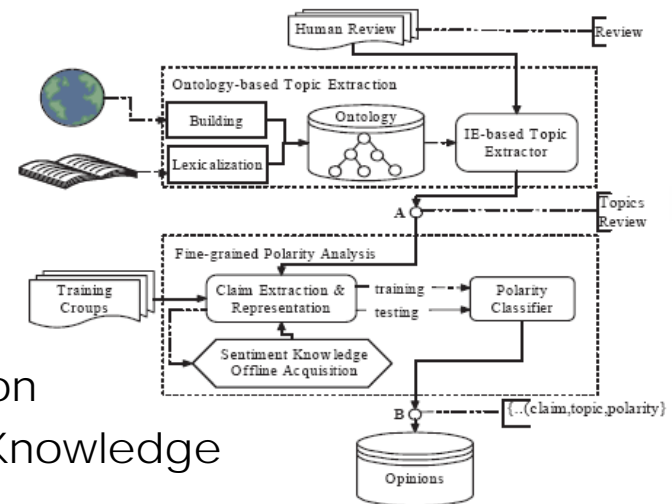
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- OMINE – ontology-based opinion mining system

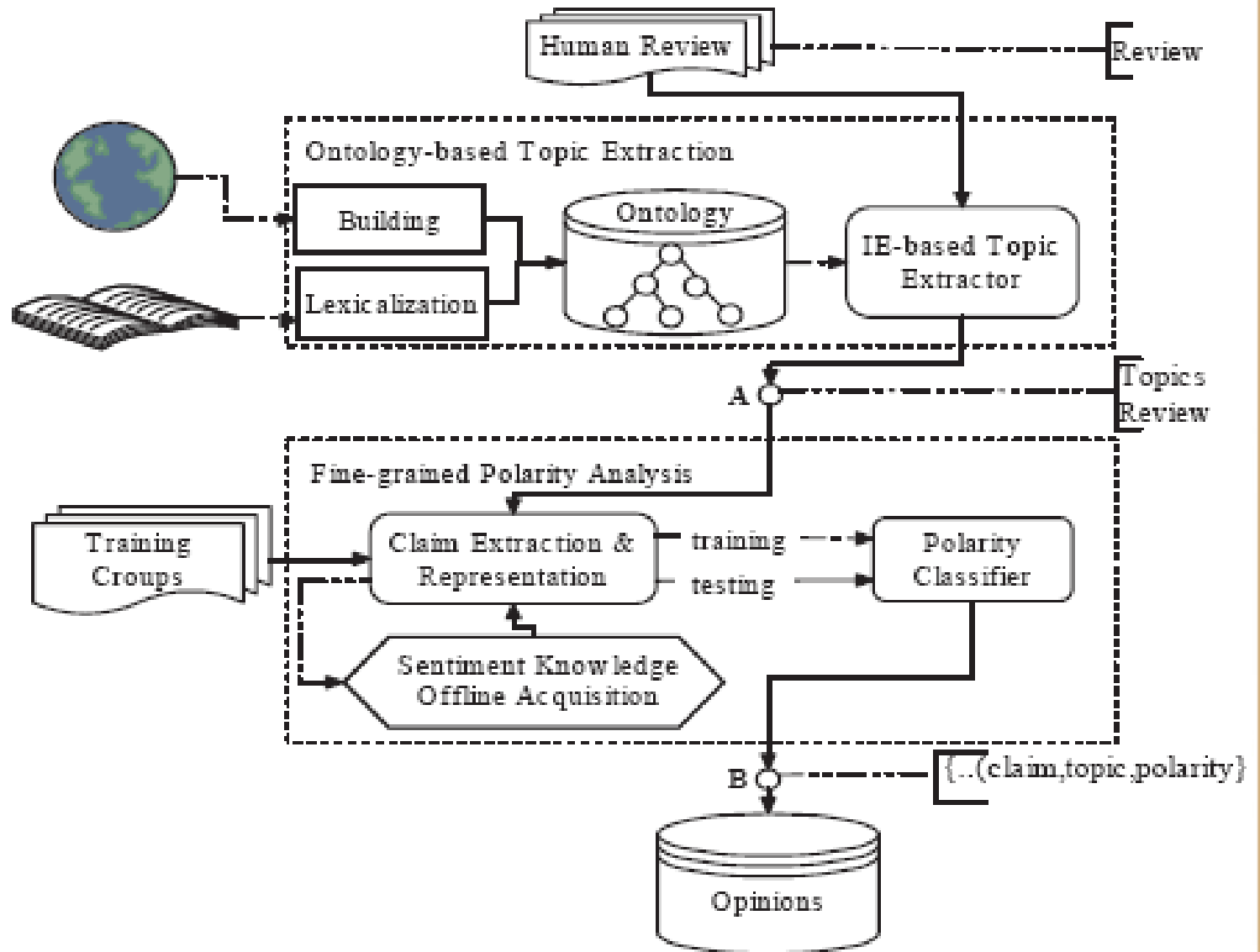


# OMINE – Opinion Mining System

- Ontology-based Topic Extraction
  - Offline Ontology Building
  - Ontology Lexicalization
  - IE-based Topic Extraction
- Fine-grained Polarity Analysis
  - Claim Extraction & Representation
  - Offline Acquisition of Sentiment Knowledge
  - Polarity Analysis







# Topic Extraction - Experiment

- Data
  - Taxonomy Resource: eBay <http://www.ebay.com> and AutoMSN <http://autos.msn.com>
  - Automobile glossary: <http://www.autoglossary.com>, around 10,000 terms
  - Data for topic extraction: 1000 sentences from UserReview of AutoMSN
  - Golden standard: 2038 terms identified manually
- CarOnto
  - 363 concepts (e.g. Air Intake & Fuel Delivery)
  - 1233 instances (e.g. 5- speed automatic overdrive)
  - 145 values (e.g. wagon for Style, 250@5800 RPM for Horsepower)
  - 803 makes and models (e.g. BMW, Z4)
  - **Ontology lexicalization is applied to 363 concepts and retrieves 9033 lexicons.**
  - **11214 domain-specific lexicon instances as total**
- Topic Extraction
  - TermExtractor (Sclano and Velardi, 2007)
  - OPINE (Popescu and Etzioni, 2005)

OntoTpcEx	Recall	Precision
Before Enrichment	20.97%	88.12%
After Enrichment	<b>89.35%</b>	<b>94.44%</b>
TermExtractor	15.72%	97.46%
OPINE	79.44%	93.12%

# Polarity Analysis- Experiment

- Data
  - Resource: UserReview From AutoMSN
  - The polarities of these reviews have already been annotated by reviewers in two classes: pro and con.
  - Around 20 thousand sentences, and 50% of them are positive and the other 50% are negative.
  - 19600 sentences are used to train the classifier, and 200 positive and 147 negative sentences are applied as a test corpus
- Acquisition of Sentiment Knowledge

Type	Precision	Num
Sentiment word	95.0%	623
Negation word	73.8%	22

POSITIVE	NEGATIVE
awesome, cute, speedy excellent, well, standard great, strong, comfortable sporty, super, adorable	unimpressive, awful, terrible useless, tremendous, costly expensive, troublesome, tight cumbersome, ugly, squeaky

POS	Negation words
aux	<i>doesn't, didn't, wouldn't, shouldn't couldn't, don't, can't, won't</i>
det	<i>no, little, least</i>
mod	<i>never, barely, not, less</i>

# Challenges

- Interaction between Pattern and Slot
  - <holder> **would like better** <object>
    - I would like better fuel mileage.
  - <object -1> drives like <**object-2**>
    - This car drives like a Porsche/a Nissan.
- Anaphoric resolution for summarization
  - E.g. "The turbo engine is a must-have, which provides acceleration."
- Others (context or semantic implication)
  - He is not the sharpest knife in the drawer.
  - She is a few fries short of a Happy Meal.
  - Stephanie McMahon is the next Stalin.
  - No one would say that John is smart.
  - My little brother could have told you that.
  - You are no Jack Kennedy.
  - They have not succeeded, and will never succeed, in breaking the will of this valiant people.
- More ...



*"Who is the fairest one of all,  
and state your sources!"*

# Reference

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*köszönöm !תודה dĕkuji*

*mahalo* 고맙습니다

*thank you*

*merci* 谢谢 *danke*

*Ευχαριστώ* شكرا

どうもありがとう *gracias*