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Machine Reading for Notion- Based Sentiment Mining

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Outline

- Motivation
- Related Work
- Proposed Approach
- Experiments and Results
- Conclusion and Future Work



Motivation

- Tons of data available online
- Consumers need to find public opinion on certain products before making a purchasing decision
- Companies need to know public opinion on their products
- Process takes time and effort
- **But !** User does not have much time to spare



Problem Statement

➡ Need an automatic process that could replace the tedious manual process, while maintaining the same quality of results an expert human reader would have obtained in case he/she had enough time and resources

➡ Automated process needs to extract features from text

Question: What features to extract ?

Related Work

- In the literature, many text features have been used
- Feature examples: Words that show the most correlation with review scores [1]
- Semantic features: semantic orientation of words
- Syntactic features: Part of Speech (POS) tags
- Stylistic features: number of words in review

Related Work

But !

- Not clear why certain features were used
- Features chosen based on: what features from the pool of available features gives the best result when used with a certain technique ?
- What if chosen features are the features a human would use when analyzing a text for sentiment ?

Related Work

- Several sentiment classification methods proposed in the literature using:
 - Learning methods such as : SVM, Naïve Bayes, and Decision trees
 - Non-learning methods which make use of scoring techniques based on sentiment word dictionaries such as SentiWordNet

Related Work

- Sentiment Mining used for:
 - Prediction of sales performance
 - Prediction of overall sentiment of unlabeled review
 - Analysis and comparison of products according to reviewers' opinions on certain product features: Ex: Opinion Observer [6], Opine [7]
 - Recommender Systems

From Related Work to Proposed Approach

- Rare are the methods that provide a solid link between human analysis of a sentiment text and machine analysis of the same text
- Proposed method will address the above by trying to follow the exact steps in a human's thought process when reading and analyzing text

PROPOSED APPROACH

Definitions

- Notion: A preconceived label assigned to a certain fact or idea.
- Ex: A human automatically associates the labels:
 - **Text:** “Comfortable chair” → **notion:** a comfortable chair is a positive thing
 - **Text:** “back pain” → **notion:** back pain is a negative thing
 - **Text:** “high maintenance” → **notion:** needing high maintenance is a negative thing
 - **Text:** “high rank” → **notion:** having a high rank is a positive thing

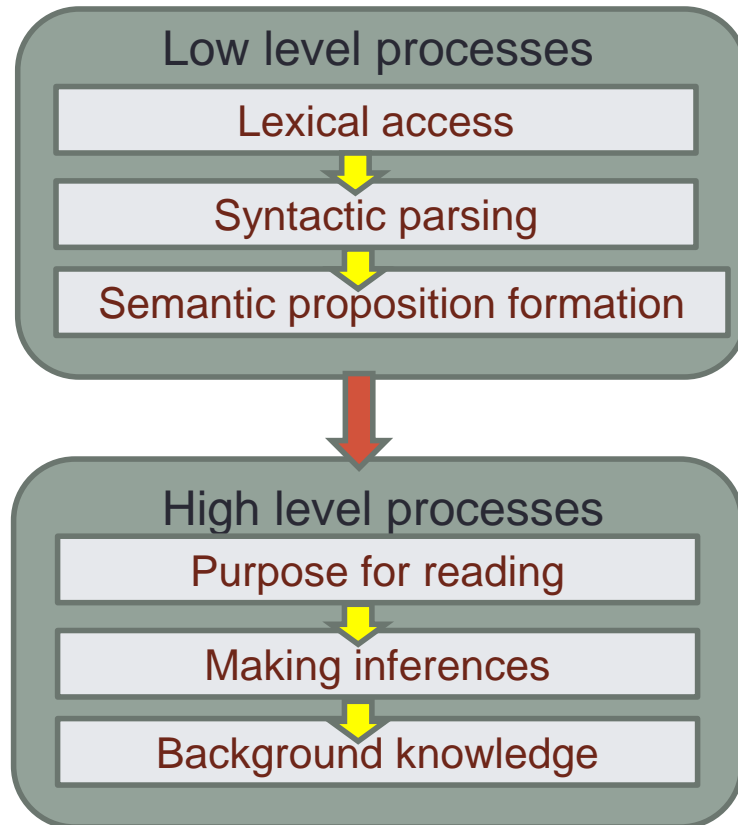
Definitions

- Product review interests:
 - Are statements or descriptions in a product review that would interest a human reading the review.
 - Could be descriptions/opinions on product features
 - Could also be recommendations from reviewer to buy/not buy product
 - Could be descriptions on behavior of product

Objectives

- Follow human steps in reading and analysis of text to extract positive/negative interests related to product.
- Deduce overall sentiment given by a review based on extracted interests and their corresponding notions.

Human Reading Process

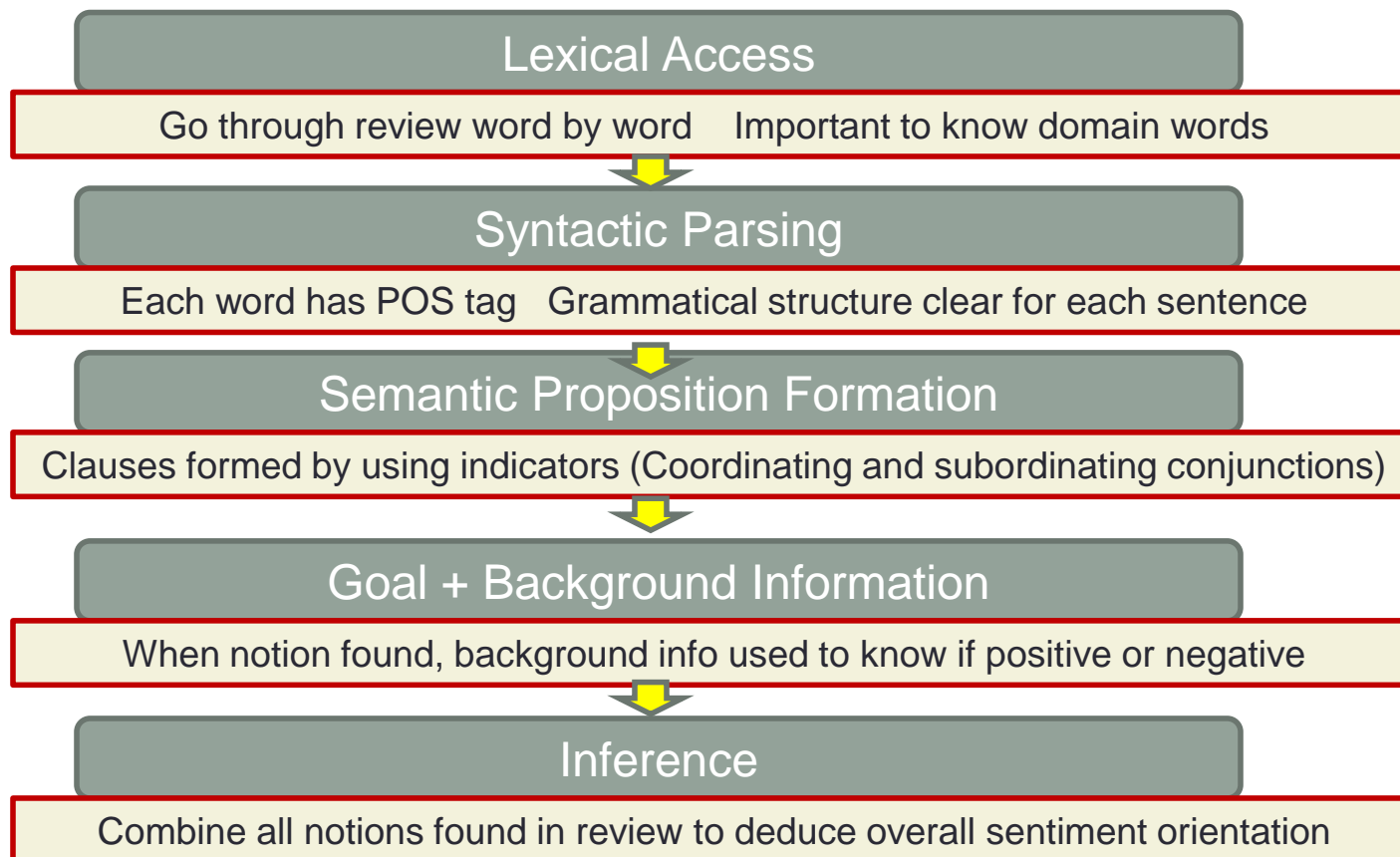


Reader uses background knowledge to analyze text

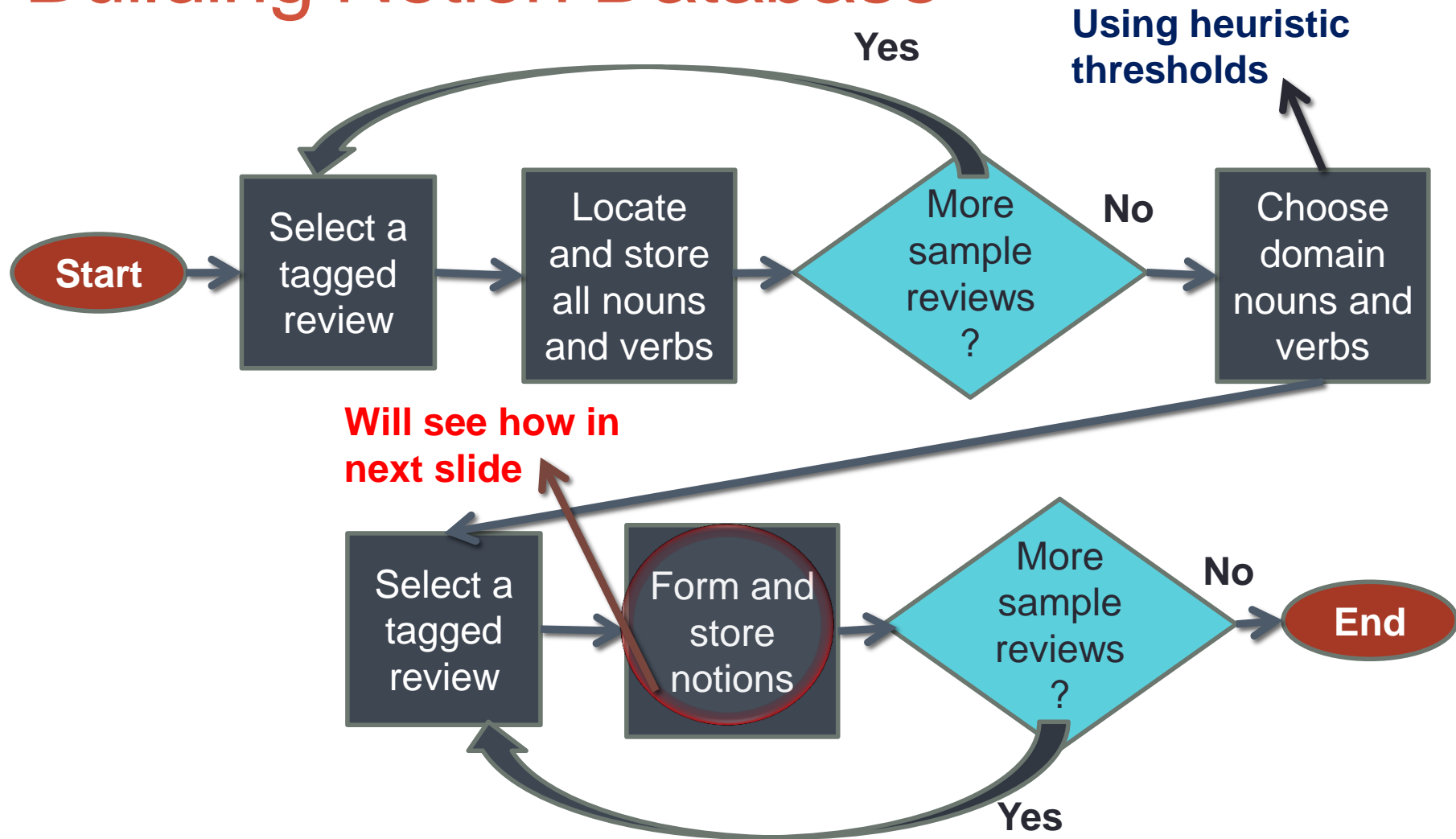
“The ability of fluent readers to integrate text and background information appropriately and efficiently is the hallmark of expert reading in a topical domain (e.g. history, biology, psychology)” [4]

There is background information specific to each domain

Machine Reading Process



Building Notion Database



Forming Notions

```

1  Inputs: tr: tagged review, db: database
2
3  While (still have untrained tr)
4      Divide tr into clauses
5      Foreach clause
6          Extract main idea from clause
7          If (main idea contains domain features)
8              If (idea not found in notions db)
9                  store idea as notion in db
10                 notion score = review rating
11             End if
12             Else
13                 update notion score in db =  $S = \frac{\sum_{i=1}^n r(i)}{n}$ 
14             End if
15         Else
16             main idea is not a domain notion => disregard it
17     End foreach
18 End while

```

Experiment Setup

- Step 1: Crawling the web for product reviews (Using RapidMiner software)
- Step 2: Extraction of useful data from downloaded pages
 - Product being reviewed
 - Product rating according to reviewer
 - Review Text



General Steps

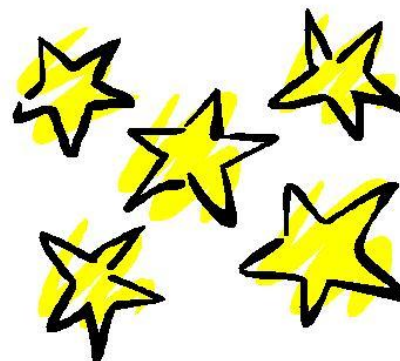
- Step 3: Mine reviews for domain features (could be nouns or verbs)
- Step 4: Go through reviews and form notions. Store notions in database.
- Testing:
 - Go through review, search for notions found in database.
 - Can display list of positive/negative notions found in review
 - If notions found, use notion orientation score to deduce overall orientation of review.

Implementation

- 5000 reviews on digital portable audio devices were extracted from Epinions [2] by using RapidMiners's Web Crawl Operator [3]
- Reviews were tagged for POS of each word
- The “bidirectional-distsim” Stanford POS tagger [5] that achieves an accuracy of around 97.1% for the English language was used to tag the reviews

Implementation

- Reviews were rated from 1 to 5 stars, 5 being the best rating, and contained:
 - 488 1-star reviews
 - 386 2-star reviews
 - 1728 4-star reviews
 - 2398 5-star reviews
- Database used: MySQL
- Programming Language: PHP



Results – Domain features/interests extraction

- Got 277 feature nouns , and 1585 feature verbs
- 10 most frequent nouns are relevant interests to someone who is reading the review

Noun	Frequency
camera	24122
picture	9951
battery	4591
quality	3535
photo	3289
time	2780
feature	2756
mode	2744
shot	2576
card	2567

Results – Notion Extraction

- Number of notions obtained : ~ 80,000

- Notice that some notions are not product features but rather things that interest a person reading the review.



Notion	Score
Look elsewhere	1.0
Not recommend camera	1.0
Warranty repair	1.0
Stopped working	1.0
Shutter speed	5.0
Love camera	5.0
Is great camera	5.0
Wide angle	5.0
Is very compact	4.22
Color are bright	4.66

Results – Sentiment Mining

- The evaluation of the proposed method's results was performed using the 5-fold cross-validation method.
- Each group of equally rated reviews was split into 5 equal parts and each part was assigned to one of the 5 groups. When one group (~ 1000 elements) was used for testing, the other groups (~ 4000 elements) were used for training.
- An average accuracy of 85 % was recorded for our notion-based approach whereas a highest accuracy of 87.01 % was achieved in one of the testing rounds.

Results – Sentiment Mining

- Confusion Matrix [6] for the testing round that achieved the best results.
- Confusion Matrix represents the distribution of the classification results in terms of True Positives (TP), True Negatives (TN), False Positives (FP), and False Negatives (FN).

Result \ Truth	Positive	Negative
Positive	802	106
Negative	24	69

Results – Sentiment Mining

$$\text{Accuracy} = \frac{(TP+TN)}{(TP+TN+FP+FN)} = \frac{(802+69)}{(802+69+106+24)} = 87.01 \%$$

- Achieving the above accuracy indicates that our proposed machine reading technique is a promising approach that is worth more thorough investigation

Conclusion

- Proposed a method that bases itself on the thought and decision process of a human when analyzing sentiments.
- Build preliminary database of human-like preconceived notions
- When tested on a set of 5000 reviews, our notion-based approach produced accurate results; the fact that proves the merit of our suggested approach.

Future Work

- A lot can be done to increase the current accuracy
- Notion detection will be complemented by synonym detection so that words indicating the same notion can be combined together
- Optimize the threshold values used in approach
 - Ex: the thresholds used in the feature selection stage.
- Investigate the benefit of combining our approach with current state-of-the art methods

Acknowledgments

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