Word Sense Disambiguation in Queries

Shaung Liu, Clement Yu, Weiyi Meng
Objectives

(1) For each content word in a query, find its sense (meaning);
(2) Add terms (synonyms, hyponyms etc of the determined sense) to the query so as to improve retrieval effectiveness.
Example

Query: Recycling automobile tire
Recycling: sense 1: cause to repeat a cycle;
Sense 2: use again after processing
disambiguated to sense 2:
A synonym: Reuse
Automobile tire has unique sense
A synonym: car tire
Generate phrases: reuse automobile tire,
reuse car tire, recycle car tire
Our Approach to determine the sense of a content word $t_1$

Find a phrase in the query containing $t_1$. Let the phrase be $(t_1, t_2)$.
Each $t_i$, $i = 1, 2$, has synonym sets, their definitions, hyponym sets, and their definitions.

The sense of $t_1$ is determined by comparing these 4 pieces of information against those of $t_2$. 
Comparison of information of $t_1$ against that of $t_2$

$t_1$  $t_2$

synonym ___ synonym

def( synonym) ___ def( synonym)

hyponym ___ hyponym

def (hyponym) ___ def( hyponym)
An Example

Phrase in query: philosophy Stoicism

A synonym of one sense, S1, of philosophy is “philosophical system”.
The definition of one sense, S2, of Stoicism contains “philosophical system”. Thus, the sense of philosophy is S1 and that of Stoicism is S2.
Another example

Query: induction, deduction
The definition of one sense, S1, of induction and that of one sense, S2, of deduction have the common words “reasoning, general”. Thus, the sense of induction is determined to be S1 and that of deduction is determined to be S2.
What happens if multiple senses of a content word are obtained?

16 cases

Two or more cases yield different senses
Resolve Multiple senses

2 key parameters:

(1) Historical accuracies of the Cases:
    Determined by experiments

(2) Likelihood that a word has a given sense: given by Wordnet (frequency)
What happens if the technique yields no sense

(1) Choose the most likely sense, if it is at least 50% chance of being correct.

(2) Use Web search to determine the sense.
Web search to determine sense of a term t

Suppose t has two senses.
From the definition of each sense of t, form a vector of content words, say V1, V2.
Submit the query containing t to Google.
From the top 20 documents, extract the content words around t to form a vector V.
Choose sense i, if sim( V, Vi) is maximum.
Experimental Results

• TREC 2004 queries, robust track

• 250 queries

• 258 unique sense terms, 333 ambiguous terms
<table>
<thead>
<tr>
<th>Case</th>
<th>Frequency</th>
<th></th>
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<tbody>
<tr>
<td>Applicability</td>
<td>65%</td>
<td>30%</td>
<td>5%</td>
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<tr>
<td>Accuracy</td>
<td>89.4%</td>
<td>93%</td>
<td>81%</td>
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<tr>
<td>Overall accuracy</td>
<td></td>
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<td>90%</td>
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</table>
Similarity function of our system

- Similarity( Q, D) =
  ( phrase similarity, term similarity);
  phrase similarity = sum of idfs of phrases;
  term similarity = Okapi similarity

D1 is ranked ahead of D2 if phrase-sim 1 > phrase-sim 2 or if phrase-sim 1 = phrase-sim 2 and term-sim 1 > term-sim 2
Recognition of phrases in queries

A phrase, say p, is recognized in a query as
(a) named entity: eg name of person or
(b) dictionary phrase: in Wordnet or
(c) simple phrase: containing two words or
(d) complex phrase: more than 2 words
Recognition of phrases in documents

A phrase $p$, say $(\text{term 1}, \text{term 2})$ appears in a document if the terms are within a certain distance.

named entity: terms need to be adjacent
dictionary phrase: terms within distance $d_1$
simple phrase: terms within $d_2$
complex phrase: $d_3$; $d_1 < d_2 < d_3$
d1, d2, d3 determined by decision tree
## Impact of WSD on effectiveness

<table>
<thead>
<tr>
<th></th>
<th>No-WSD</th>
<th>WSD</th>
<th>Improvement</th>
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<tbody>
<tr>
<td>TREC6</td>
<td>.28</td>
<td>.32</td>
<td>17%</td>
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<tr>
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<td>.25</td>
<td>.31</td>
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<td>.32</td>
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<td>.34</td>
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<tr>
<td>Overall</td>
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<td>.35</td>
<td>13.7%</td>
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(Previous best known result: .33)
Summary

• Utilizes 3 methods for word sense disambiguation.
• Case analysis, guessing based on frequency, Web search
• Yields 100% coverage and 90% accuracy
• Improves retrieval effectiveness
Comparison with other word sense disambiguation algorithm

• Earlier works mostly disambiguates words in documents rather than in queries

• Previous “best” result is around 71% accuracy.
Conclusion

• Accuracy of our current system is around 90%.
• Yields improvement in retrieval effectiveness
• Will attempt to improve both accuracy in word sense disambiguation and retrieval effectiveness