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Uncertainty detection in natural language

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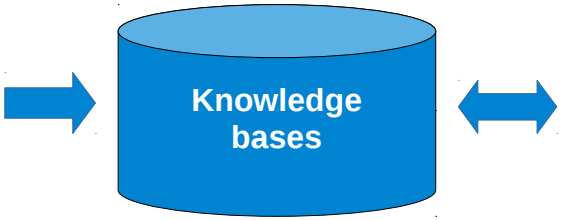
Positioning

General context

Take into account uncertainty in enrichment and utilization of knowledge bases for decision making.

Enrichment

- **Information extraction**
  - + Named entity recognition
  - + Relation extraction
- **Uncertainty detection**
  - + Binary detection
  - + Scope of the uncertainty



Utilization

- **Knowledge inference**
  - + Knowledge discovery
  - + Rules mining
  - + Inconsistency detection
- **Decision making**
- **Question answering**

Uncertainty markers

Uncertainty *

Semantic uncertainty

Semantically uncertain propositions cannot be assigned a truth value *i.e.* it cannot be stated for sure whether they are true or false, given the speaker's current mental state

« *It <u>may</u> be raining.* »

Discours-level uncertainty

Lack intentionnal or not of information from the speaker (source, imprecision, subjectivity)

« *<u>It has been suggested</u>* [***by whom?***] *that he should have involved Clinton much more heavily in his campaign.* »

- **Markers:**
  - **Auxiliary** (verbes modaux): *may, should, would, might*
  - **Speculative verbs** : *suspect, seem, presume*
  - **Adjectives and adverbs** : *probably, likely, perhaps, often*
  - **Fuzzy numeric expressions** : *many, most, some, Experts say, some people*

* Szarvas, G., Vincze, V., Farkas, R., Móra, G., & Gurevych, I. **Cross-genre and cross-domain detection of semantic uncertainty**. Computational Linguistics. 2012.

Results CoNLL 2010 – *Task* 1

	BioScope [1]	WikiWeasel [2]
Uncertainty dimension	Semantic	Semantic / Discourse-level
Best F-measure de CoNLL 2010	Tang et al. – **86,4 %** (55 % on WikiWeasel)	Georgescul et al. – **60,2 %** (78,5 % on BioScope)

Summary

- The kind of texts
- The dimension of uncertainty

} impact methods efficiency

[1] Veronika Vincze, György Szarvas, Richárd Farkas, György Móra, and János Csirik: **The BioScope corpus: annotation for negation, uncertainty and their scope in biomedical texts.** BMC Bioinformatics, 9(Suppl 11):S9. 2008.

[2] Farkas, R., Vincze, V., Móra, G., Csirik, J., & Szarvas, G. **The CoNLL-2010 shared task: learning to detect hedges and their scope in natural language text**. Conference on Computational Natural Language Learning (p. 1-12). 2010.

Overview

Training

Labelled sentence n°1
Labelled sentence n°2
...

Feature engineering

	Feature n°1	Feature n°2	Feature n°3	...
Sentence n°1	0,32	0,5	0,02	...
Sentence n°2	0,1	0,12	0,01	...

Support Vector Machine

SVM Model

Prediction

Sentence n°1
Sentence n°2
...

Support Vector Machine

Sentence n°1 – Uncertain
Sentence n°2 – Certain
...

Features

Overall feature				
- Length of the sentence				
Local features				
	Type	Length	Context	Aggregation
Feature 1	Stem	1	Uncertainty markers	Sum
Feature 2	Stem	2	Uncertainty markers	Sum
Feature 3	Stem	1	In uncertain sentence	Sum
Feature 4	PoS	5	In uncertain sentence	Sum
Feature 5	Stem	1	In uncertain sentence	Max

Feature 1 : TCF-1 might play a role in the establishment of ...

→ Sum w1 + w2 ...

Feature 2 : TCF-1 might play a role in the establishment of ...

→ Sum w1 + w2 ...

Feature 4 : NN MD VB DT NN IN DT NN IN ...

→ Sum w1 + w2 ...

Probabilist measure

	Type	Lenght	Context	Aggregation
Feature 1	Stem	1	Uncertainty markers	Sum
Feature 3	Stem	1	In uncertain sentence	Sum

Conditional probability

$S_{i,train} = w_1 \; w_2 \; w_3 \; \ldots \; w_n$

	$\#_{context}$	$\#_{tot}$	%
w_1	1	4	25
w_2	1	1	100
w_3	100	100	100

Feature 1

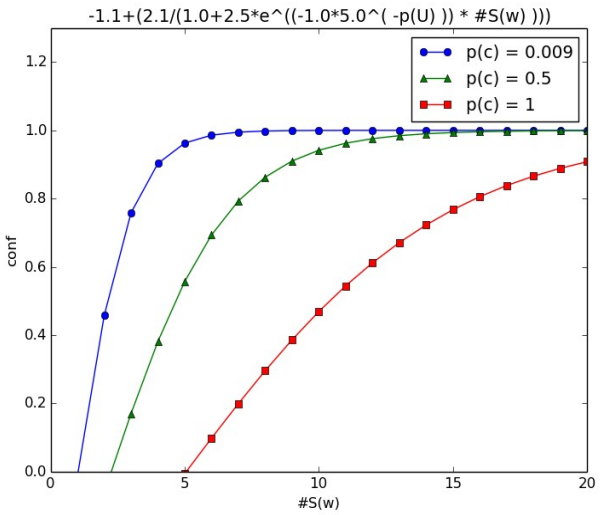
$S_{j,eval} = w_1 \; w_2 \; w_3 \; \ldots \; w_n$

- Uncertainty marker unigrams F_1

$$F_1 = \sum_{k=1}^{n} p\left(w_k \in I_{Su}\right) \times conf_{I_{Su}}\left(w\right)$$

Confidence score

- Allows to evaluate the relevance of specific ngram in taking into account its **number of occurrences** in the corpus and the **probability** to pick randomly an uncertainty marker in the corpus.

Binomial law	Sigmoid function	Control measure
$p(X \geq k) = \sum_{i=k}^{n} \binom{n}{i} p^i (1-p)^{n-i}$		$conf(w) = 1 - \frac{1}{S(w)}$

Results with the conditional probability

	BioScope (86,4 %)	WikiWeasel (60,2 %)	SFU corpus (92,3 %)
Binomial law	79,4	61,4	92,2
Sigmoid	**79,5**	61,7	**92,3**
1 – 1 / s(w)	**79,5**	**62,8**	**92,3**
Without confidence	79,4	59,2	**92,3**

Tang et al. BioScope : 86,4 %
WikiWeasel : 55 %
} Average : 70,7 %

Georgescul et al. BioScope : 78,5 %
WikiWeasel : 60,2 %
} Average : 69,35 %

Notre méthode BioScope : 79,5 %
WikiWeasel : 62,8 %
} **Average : 71,2 %**

- Large disparity between corpuses (nature, number and distribution of uncertainty markers)
- Wikiweasel data are more sparse
- The p probability (success probability) is not required to improve results

Results with many metrics

	BioScope	WikiWeasel	SFU
Conditional probability, 1 – 1 / s(w)	79,5 %	62,8 %	92,3 %

Measures	Confidence	BioScope	WikiWeasel	SFU
PMI	log(#s(w))	75,6 %	33,8 %	88,3 %
	1-1/#s(w)	77,3 %	40,6 %	91,1 %
	Binomial law	76,6 %	52,3 %	91,5 %
	Sigmoid	77,1 %	37,7 %	91 %
	Without confidence	76,4 %	35,1 %	90,6 %
Odds Ratio	log(#s(w))	78,1 %	45,5 %	91,1 %
	1-1/#s(w)	**79,3 %**	52 %	92,1 %
	Binomial law	**79,3 %**	**55 %**	**92,2 %**
	Sigmoid	**79,3 %**	51,5 %	92,1 %
	Without confidence	79,2 %	51,3 %	92,1 %
CPD	log(#s(w))	70,8 %	45,2 %	78,6 %
	1-1/#s(w)	70,4 %	49,9 %	78 %
	Binomial law	69,7 %	48,1 %	80,1 %
	Sigmoid	70,5 %	48,6 %	78,1 %
	Without confidence	69,6 %	48 %	73,3 %
Wllr	log(#s(w))	53,7 %	16,5 %	69,8 %
	1-1/#s(w)	55,1 %	11 %	66,3 %
	Binomial law	55,5 %	45 %	67,1 %
	Sigmoid	55,1 %	11,6 %	65,8 %
	Without confidence	55,1 %	18,9 %	65,7 %

Conclusion

- Short vectorial representation of sentences realized by at most 6 features becoming to a specific aggregation of n-gram's weights
- Weighted sentence's n-grams with their conditional probability to belong to a specific class *c* (according to their context)
- Modelisation of a confidence score to distinguish more relevant n-grams
- Improvement of F-measure on WikiWeasel and the average of F-mesures on the corpus used during CoNLL 2010

Thank you

- Vectorial representation of sentence
- Weighted sentence's n-grams
- Confidence score to distinguish n-grams
- Improvement of F-measure of CoNLL 2010

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