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Faceted Textual Entailment

Selected comments and remarks

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Textual Entailment

Initial definitions

- "By *textual entailment* is understood a relationship between coherent text *T* and a language expression *H*, which is considered as a hypothesis. *T entails H* if the meaning of *H* as interpreted in context of *T*, can be deduced from the meaning of *T*."
- "*Textual entailment* is an asymetric relation between two text fragments that describes whether one fragment can be inferred from the other."

If *T* entails *H*, we usually write $T \longrightarrow H$.

Recognizing Textual Entailment (RTE) Task

Binary decision problem

Recognizing Textual Entailment (RTE) is a binary task: whether a given (coherent) text T entails a given text H (in this context often called hypothesis).

If $T \not\rightarrow H$, there is no way how to measure how close is H to some H' such that $T \rightarrow H'$. In other words, from the RTE viewpoint, a hypothesis H_u completely unrelated to the text T is handled in the same way as a hypothesis H_a that is “almost entailed”

Current Approaches to RTE

Basic classification

- Approaches dealing with sequences of words: bag-of-words methods, vector space based models
- Advanced approaches: logic based, syntactic-similarity based, decoding methods

Why RTE?

Potentially Myriads of Applications

- Paraphrase detection
- Multi-document summarization
- Machine translation evaluation
- Plagiarism detection
- Computing semantic similarity of textual document

Partial Textual Entailment

Initial Definition

An ordered pair $(T; H)$ forms a partial textual entailment (abbr. as PTE) if *a fragment* of the hypothesis H is entailed by T.

Remark: In this definition, the fragment of the hypothesis is no more defined. Hence, the key question is how to decompose the hypothesis into fragments.

Facets

Special types of fragments

A facet is an ordered pair of words (f_1, f_2) that are contained in the hypothesis – accompanied by a semantic relation binding these words together. A simplified version of this approach – used in SemEval 2013 challenge – deals only with a pair of words *without* the semantic relation mentioned explicitly.

For example, if the hypothesis has the form of a sentence “The water was evaporated, leaving the salt.”, one of corresponding facets is (evaporated, water).

Recognizing Faceted Textual Entailement

Our Basic Setting

The problem of recognizing faceted entailment can be stated as follows: *"Does the given text T express the same semantic relationship between the words f_1 and f_2 (that form the facet) exhibited in H?"*

We have proposed a simple system for recognizing faceted textual entailment based on word2vec model.

Word2vec Model

Key Component of Our Approach

- word2vec model belong to a class of distributed representations for words.
- representations of (semantically) similar words are close in the vector space.
- word2vec model arises from the idea of predicting the neighbors of a word using a neural network – weights between input and first hidden layer constitute the word representations
- word2vec model can capture many regularities of the language: vector $rep(\mathrm{France}) - rep(\mathrm{Paris})$ is close to the vector $rep(\mathrm{Italy}) - rep(\mathrm{Rome})$

Word2vec Algorithm for Faceted Textual Entailment

Algorithm description

1. Split the text T into tokens $t_1, \ldots, t_n$.
2. Get the word2vec representations $r(t_1), \ldots, r(t_n), r(f_1), r(f_2)$ whenever possible.
3. For f_1 select the word t_p such that $d(r(f_1), r(t_p))$ is equal to $\min\{d(r(f_1), r(t_k)) \mid 1 \leq k \leq n\}$, where d is the standard cosine distance. For f_2 select analogously t_q. Roughly said, select two words in T that have the lowest distances to the facets in the sense of word2vec space.
4. If $\frac{d(r(f_1),r(t_p))+d(r(f_2),r(t_q))}{2} \geq \alpha$ than (f_1, f_2) is *Expressed* in T, otherwise (f_1, f_2) is *Unaddressed* by T. If some word of the facet is missing in the word2vec model, the result class is set to *Unaddressed*.

Recognizing Faceted Entailement

SciEnts Bank example

QUESTION: *You used several methods to separate and identify the substances in mock rocks. How did you separate the salt from the water?*
STUDENT ANSWER: *Let the water evaporate and the salt is left behind.*
REFERENCE ANSWER: *The water was evaporated, leaving the salt.*
FACET: *(evaporated, water)*
In this case, the result is “Expressed” (thus the student’s answer can be regarded as partially correct).
In contrast, when student answers “I don’t know.” the facet *(evaporated, water)* is obviously not expressed.

Figures

Basic results achieved over SciEnts Bank corpus

	Precision	**Recall**	F_1**-score**
Expressed	0.661	0.811	0.729
Unaddressed	0.875	0.761	0.814
Macroaverage	0.768	0.786	0.771
Microaverage	0.797	0.779	0.783

Table: W2V $\vee$ EXACTMATCH results

From Faceted Entailment to Complete Entailment

From partial information to decision about the complex problem

Let us consider a following situation:

TEXT: The robber escaped in a BMW.

HYPOTHESIS: The robber escaped in a Mercedes.

FACETS: (robber, escaped), (escaped, Mercedes)

In a crisp case, we have a threshold, binary results – and we can state that hypothesis is entailed in all of its facets are expressed in the text.

Shifting to Fuzzy Level

No thresholds, but using aggregation operators on individual results about facets.

Algorithm for fuzzy textual entailment IN A SKETCH: decompose the hypothesis into facets (manually or using ML algorithm), compute the “truth degree” of facet entailment from the text and aggregate these values over all facets (improvement by weights).

KEY QUESTION: Evaluation. For crisp case there are several corpora (test suites), in the fuzzy case there are none.

Acknowledgement

Comments, remarks...

Thank you for your attention!