



A classification model for semantic entailment recognition with feature combination

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ABSTRACT

Recent years have witnessed the fast development of multimedia platforms in China, such as Youku, LeTV and Weibo. Images and videos are usually uploaded with textual descriptions, such as titles and introductions of these media. These texts are the key to multimedia content understanding, and this paper is dedicated to multimedia understanding with visual content entailment via recognizing semantic entailment in these texts. In fact, the natural language processing community has been manifesting increasing interest in semantic entailment recognition in English texts. Yet, so far not much attention has been paid to semantic entailment recognition in Chinese texts. Therefore, this paper investigates on multimedia semantic entailment with Chinese texts. Recognizing semantic entailment in Chinese texts can be cast as a classification problem. In this paper, a classification model is constructed based on support vector machine to detect high-level semantic entailment relations in Chinese text pair, including entailment and non-entailment for the Binary-Class and forward entailment, reverse entailment, bidirectional entailment, contradiction and independence for the Multi-Class. We explore different semantic feature combinations based on three kinds of Chinese textual features, including Chinese surface textual, Chinese lexical semantic and Chinese syntactic features, and utilize them to feed our classification model. The experiment results show that the accuracy of our classification model for semantic entailment recognition with the feature combination using all the three kinds of Chinese textual features achieves a much better performance than the baseline in Multi-Class and slightly better results than the baseline in the Binary-Class.

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1. Introduction

The emerging of semantic entailment is mainly due to the variability of semantic expression, which is the fundamental and essential characteristic of natural language and other types of media. The variability of semantic expression means the same meaning can be expressed or inferred by more than one expression, and therefore the semantic entailment tries to recognize the different semantic expressions with the same or similar meaning. Theoretically, the constraint of semantic entailment is less

restrictive than logical entailment and a common definition of semantic entailment in formal semantics from multimedia perspective is formulated as a multimedia $m1$ entails another multimedia $m2$ if the multimedia $m2$ is almost likely true in each conceivable circumstance in which the multimedia $m1$ is true.

As the rising of social media platforms, millions of images and videos are uploaded to the Web daily, and this has led to urgent requirement of multimedia understanding at semantic level assisting in media search, processing and management. The semantic entailment can explore the relevance in multimedia and enhance the deep multimedia understanding, but it is very difficult to directly recognizing semantic entailment in multimedia pair at present. Let consider the following pictures in Fig. 1 as example.¹ The picture in Fig. 1(1) can obviously entail the one in

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¹ Selected from <http://yuetu.163.com/>



Fig. 1. Example with semantic entailment in images.

Fig. 1(2) at visual semantic level, but so far the semantic entailment in images is in its infancy.

Fortunately, these multimedia with objects or activities in it usually are described by some surrounding texts containing nouns denoting entities or action verbs meaning activities as aforementioned. In Fig. 1, we can easily find that the text “A Hmong man has grasped a living fish in ‘Fish Festival’” in Fig. 1(1) can entail the text “People are in the scramble for the fish in ‘Fish Festival’” in Fig. 1(2). So we can infer multimedia semantic entailment by semantic entailment in their surrounding texts. Understanding multimedia contents by exploring textual information is a popular way in the multimedia communities. This work presents a novel model to understand the multimedia contents by semantic entailment recognition in their surrounding texts.

The semantic entailment is actually a very important type of semantic relations in media, e.g. texts or text fragments, named textual semantic entailment in Natural Language Processing (NLP) area. Moreover, textual semantic entailment has also been playing vital roles in many NLP applications, such as Multimedia Question Answering (MQA), Information Extraction (IE), Multi-Document Summarization (MDS) and Machine Translation (MT) evaluation. These NLP applications need a model for the variability phenomenon of natural language in order to recognize that a particular target meaning can be inferred from different expressions. On the other hand, in the big dataset collected from social media and the other sources, there also exist the semantic entailment relations to assist in media search and inference.

In recent years, the NLP community is getting increasingly interested in studying semantic entailment recognition in English texts [1–8]. In fact, there also exists the variability phenomenon of semantic expression in the other kinds of natural language, especially Chinese. However, so far, not much attention has been paid to semantic entailment in Chinese texts. With the exponential growth of Chinese online content, especially traditional textual content in Chinese websites and User Generated Contents (UGCs) in Chinese social media services, semantic entailment is indeed a pervasive linguistic phenomenon, especially in Chinese texts, and worthy of being deeply and thoroughly investigated. For example, there exists textual semantic entailment in the following two Chinese texts, i.e. Text1 can entail Text2, in Example 1.

Example 1. In Chinese:

Text1: 大量使用类固醇对某些人容易引起高血压，特别是在原本就有肾脏疾病者，长期服用会降低免疫力。

Text2: 大量使用类固醇者，可能免疫功能会变差。

In English²:

Text1: Extensive use of steroids easily lead to high blood pressure for some people, especially in pre-existing renal disease, long-term use can reduce the immune system.

Text2: Extensive use of steroids, and immune function may deteriorate.

² The English versions for all examples in this paper are translated from the Chinese ones.

This paper focuses on the Binary-Class (BC), i.e. entailment and non-entailment, and the Multi-Class (MC), i.e. forward entailment (F), reverse entailment (R), bidirectional entailment (B), contradiction (C) and independence (I), in Chinese text pairs. The task of semantic entailment recognition in Chinese text pair is actually one classification problem. Given two Chinese texts t_1 and t_2 , the goal is to classify the text pair (t_1, t_2) as either entailment or non-entailment for the BC and one of the five classes for the MC. So the Chinese semantic entailment recognition is the binary-way classification task for the BC or the five-way classification task for the MC.

In this paper, Support Vector Machine (SVM) is adopted to make the decision that which category of semantic entailment the given Chinese text pair should belong to according to the features of the Chinese text pair. In our SVM based classification model, three kinds of Chinese textual features, including Chinese Surface Textual Feature (CSTF), Chinese Lexical Semantic Feature (CLSF) and Chinese Syntactic Feature (CSF), will be extracted to utilize for the training and testing datasets.

The CSTF, especially similarity score, is not enough for semantic entailment recognition in text pairs [7], and recognizing semantic entailment between two texts often requires knowledge that is not explicitly encoded in the two texts [8]. Therefore, the feature combinations, CSTF+CLSF and CSTF+CLSF+CSF, will be used in our experiments to improve the recognition accuracy.

The main contributions of this paper are threefold:

- (1) We present a classification model to understand the multimedia contents by semantic entailment recognition in their surrounding texts.
- (2) We investigate the variability of semantic expression in Chinese language and attempt to recognize the semantic entailment in Chinese text pairs.
- (3) We combine three kinds of Chinese textual features to predict semantic entailment in Chinese texts.

The remainder of this paper is organized as follows. Section 2 reviews related work. Section 3 shows our semantic entailment classification model containing three kinds of textual features. Section 4 then presents experiments and discussions. Finally, Section 5 concludes the paper and suggests the future work.

2. Related work

Some work has paid attention to bridging multimedia and their surrounding texts at semantic level. Chang et al. put forward to select the most relevant semantic concepts from the textual side information for multimedia event detection [9], and in their following work, they defined a novel notion of semantic saliency for complex event detection based on semantic entailment with textual description [10]. Young et al. proposed to use the visual denotations of linguistic expressions, derived from their described images, to define novel denotational similarity metrics being benefit the semantic inference, and construct the denotation graph based on a large corpus of images and their corresponding

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