Chapter 7

Annotating and Analyzing the Interactions between Meaning Relations

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Abstract Pairs of sentences, phrases, or other text pieces can hold semantic relations such as paraphrasing, textual entailment, contradiction, specificity, and semantic similarity. These relations are usually studied in isolation and no dataset exists where they can be compared empirically. Here we present a corpus annotated with these relations and the analysis of these results. The corpus contains 520 sentence pairs, annotated with these relations. We measure the annotation reliability of each individual relation and we examine their interactions and correlations. Among the unexpected results revealed by our analysis is that the traditionally considered direct relationship between paraphrasing and bi-directional entailment does not hold in our data.

7.1 Introduction

Meaning relations refer to the way in which two sentences can be connected, e.g. if they express approximately the same content, they are considered paraphrases. Other meaning relations we focus on here are textual entailment and contradiction[1] [Dagan et al., 2006], and specificity.

Meaning relations have applications in many NLP tasks, e.g. recognition of textual entailment is used for summarization [Lloret et al., 2008] or machine translation evaluation [Padó et al., 2009], and paraphrase identification is used in summarization [Harabagiu and Lacatusu, 2010].

The complex nature of the meaning relations makes it difficult to come up with a precise and widely accepted definition for each of them. Also, there is a difference between theoretical definitions and definitions adopted in practical tasks. In this paper, we follow the approach taken in previous annotation tasks and we give the annotators generic and practically oriented instructions.

Paraphrases are differently worded texts with approximately the same content [Bhagat and Hovy, 2013, De Beaugrande and Dressler, 1981]. The relation is symmetric. In the following example, (a) and (b) are paraphrases.

(a) *Education is equal for all children.*

(b) *All children get the same education.*

Textual Entailment is a directional relation between pieces of text in which the information of the *Text* entails the information of the *Hypothesis* [Dagan et al., 2006]. In the following example, Text (t) entails Hypothesis (h):

(t) *All children get the same education.*

(h) *Education exists.*

Specificity is a relation between phrases in which one phrase is more precise and the other more vague. Specificity is mostly regarded between noun phrases [Cruse, 1977, Enç, 1991, Farkas, 2002]. However, there has also been work on specificity on the sentence level [Louis and Nenkova, 2012]. In the following example, (c) is more specific than (d) as it gives information on who does not get good education:

(c) *Girls do not get good education.*

(d) *Some children do not get good education.*

[1] Mostly, contradiction is regarded as one of the relations within an entailment annotation.

Semantic Similarity between texts is not a meaning relation in itself, but rather a gradation of meaning similarity. It has often been used as a proxy for the other relations in applications such as summarization [Lloret et al., 2008], plagiarism detection [Alzahrani and Salim, 2010, Bär et al., 2012], machine translation [Padó et al., 2009], question answering [Harabagiu and Hickl, 2006], and natural language generation [Agirre et al., 2013]. We use it in this paper to quantify the strength of relationship on a continuous scale. Given two linguistic expressions, semantic text similarity measures the degree of semantic equivalence [Agirre et al., 2013]. For example, (a) and (b) have a semantic similarity score of 5 (on a scale from 0-5 as used in the SemEval STS task) [Agirre et al., 2013, 2014].

Interaction between Relations Despite the interactions and close connection of these meaning relations, to our knowledge, there exists neither an empirical analysis of the connection between them nor a corpus enabling it. We bridge this gap by creating and analyzing a corpus of sentence pairs annotated with all discussed meaning relations.

Our analysis finds that previously made assumptions on some relations (e.g. paraphrasing being bi-directional entailment [Madnani and Dorr, 2010, Androutsopoulos and Malakasiotis, 2010, Sukhareva et al., 2016]) are not necessarily right in a practical setting. Furthermore, we explore the interactions of the meaning relation of specificity, which has not been extensively studied from an empirical point of view. We find that it can be found in pairs on all levels of semantic relatedness and does not correlate with entailment.

7.2 Related Work

To our knowledge, there is no other work where the discussed meaning relations have been annotated separately on the same data, enabling an unbiased analysis of the interactions between them. There are corpora annotated with multiple semantic phenomena, including meaning relations.

7.2.1 Interactions between Relations

There has been some work on the interaction between some of the discussed meaning relations, especially on the relation between entailment and paraphrasing, and also on how semantic similarity is connected to the other relations.

Interaction between Entailment and Paraphrases According to Madnani and Dorr [2010], Androutsopoulos and Malakasiotis [2010], bi-directional entailment