From Discourse Analysis to Argumentation Schemes and Back: Relations and Differences

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Abstract. In argumentation theory, argumentation schemes are abstract argument forms expressed in natural language, commonly used in everyday conversational argumentation. In computational linguistics, discourse analysis have been conducted to identify the discourse structure of connected text, i.e. the nature of the discourse relationships between sentences. In this paper, we propose to couple these two research lines in order to (i) use the discourse relationships to automatically detect the argumentation schemes in natural language text, and (ii) use argumentation schemes to reason over natural language arguments composed by premises and a conclusion. In particular, we analyze how argumentation schemes fit into the discourse relations in the Penn Discourse Treebank and which are the argumentation schemes which emerge from this natural language corpus.

1 Introduction

Argumentation theory [25] has been proposed to tackle a variety of problems in Artificial Intelligence (AI). In particular, reasoning systems have to interact not only with intelligent agents but also with humans. This means that they should be able to reason not only in a purely deductive monotonic way, but they need to carry out presumptive, defeasible reasoning. Moreover, the arguments behind this reasoning must be expressed in a dialogical form such that they can be consumed by humans too. Argumentation schemes [33] have been introduced to capture reasoning patterns which are both non-deductive and non-monotonic as used in everyday interactions. In computational linguistics, the issue of representing the structure of the arguments used by humans in everyday interactions has been analyzed in particular in *discourse analysis*, that aims at identifying the discourse structure of connected text, i.e. the nature of the discourse relationships between sentences [18]. However, despite the common points in the goal of these two research lines, a clear analysis of their similarities and differences is still missing, which is a required step towards the definition of computational models of natural language arguments. The research question we answer in this paper is:

– How to bridge the argument patterns proposed in argumentation schemes, and in discourse analysis towards a better account of natural language arguments?

This question breaks down into the following subquestions:

J. Leite et al. (Eds.): CLIMA XIV, LNAI 8143, pp. 1–17, 2013.

1. What is the connection between argumentation schemes and discourse relations detected in discourse analysis?
2. Do discourse relations bring to light new argumentation schemes not considered so far?

The reference corpus for discourse relations is the Penn Discourse Treebank (PDTB) [23]. We choose to ground our experimental analysis on this corpus because it is a standard reference in the natural language processing (NLP) research field, and it is currently the largest collection of documents manually annotated with discourse relations. It contains 34,683 relations annotated over the 1 million words Wall Street Journal Corpus, divided into *explicit* (i.e. signaled by an overt connective) and *implicit* relations (for more details, see Section 3). Each relation has also been annotated with a sense label, following a hierarchical classification scheme (see Fig.1). The PDTB adopts a theory-neutral approach to the annotation, making no commitments to what kinds of high-level structures may be created from the low-level annotations of relations and their arguments. This approach has the appeal of allowing the corpus to be useful for researchers working within different frameworks, while at the same time providing a resource to validate the various existing theories of discourse structure. For all these reasons, it is the most suitable resource for our study.

The comparison we perform is composed of two steps. First, we select five argumentation schemes, namely *Example, Cause to Effect and Effect to Cause, Practical Reasoning, Inconsistency*, and we map these patterns to the categories used to characterize the discourse relations in the PDTB. We highlight which relations can be annotated with the corresponding scheme, and we extract the connectives characterizing each scheme in this natural language (NL) data. Finally, we explain why certain discourse relations are not considered in the present analysis.

Second, we start from the discourse relations used in the PDTB and we show which of them can be adopted to define new argumentation schemes that emerge from this annotated corpus. In particular, we introduce two additional argumentation schemes which *emerge* from such corpus: *Argument from Equivalence*, and *Argument from Specification*. These two additional argumentation schemes support reasoning when a certain situation occurs, and they conclude, by equivalence or by specification, which other situation may also occur. We point out the differences with the existing schemes and we instantiate the new schemes with examples extracted from the PDTB.

The advantage of this analysis is threefold. First, the dataset resulting from this investigation, where the categories of the PDTB are annotated with the schemes they are associated with, represents a rich training corpus fundamental for the improvement of the state of research in argumentation in computational linguistics, as highlighted by Feng and Hirst [9]. Second, this dataset represents a first step towards the definition of a benchmark for the argumentation research community, where the actual arguments' structures used in everyday argumentation can be used to test the next generation of systems grounded on argumentation schemes and able to automatically deal with natural language arguments. Third, this mapping between argumentation schemes and PDTB relations can be fruitfully used to support automated classification [9] or argument processing [3].

In this paper, we do not use NL semantics for a better understanding of critical questions in argumentation schemes [35], and we do not present a classification framework to automatically detect the argumentation schemes in the corpus.

The layout of the paper is as follows. In Section 2 we provide the basic ideas underlying the definition of argumentation schemes, as well as the description of the schemes we consider. In Section 3 we introduce the basic notions of discourse analysis and the Penn Discourse Treebank. Section 4 presents our analysis on how argumentation schemes are represented in the PDTB, and which schemes emerge from it. In Section 5, we summarize the related research comparing it with the proposed approach. We conclude discussing some future perspectives.

2 Argumentation Schemes

Argumentation schemes [33] are argument forms that represent inferential structures of arguments used in everyday discourse. In particular, argumentation schemes are exploited in contexts like legal argumentation [12], inter-agent communication [28,19], and pedagogy [30]. They are motivated by the observation that most of the schemes that are of central interest in argumentation theory are forms of plausible reasoning that do not fit into the traditional deductive and inductive argument forms [25]. Each scheme is associated with a set of so called *critical questions* (CQ), which represent standard ways of critically probing into an argument to find aspects of it that are open for criticism. In particular, the combination of an argumentation scheme and critical questions is used to *evaluate* the argument in a particular case: the argument is evaluated by judging if all the premises are supported by some weight of evidence. In this case, the weight of acceptability is shifted towards the conclusion of the argument which is further subject to a rebuttal by means of the appropriate critical question. In the literature, some works have distinguished different types of critical questions that cover *rebuttals*, *assumptions* and *exceptions*, which are important when argumentation schemes are used in procedural or dialogical contexts, in particular when we deal with the notion of burden of proof [11]. Let us consider the following argumentation scheme.

Argument from Example

Premise: In this particular case, the individual a has property F and also property G.
Conclusion: Therefore, generally, if x has property F, then it also has property G.

This scheme is one of the most common types of reasoning in debates [16] since it is used to support some kinds of generalization. The *Argument from Example* is a weak form of argumentation that does not confirm a claim in a conclusive way, nor associates it with a certain probability, but it gives only a small weight of presumption to support the conclusion. Three examples of critical questions for the *Argument from Example* scheme are the following:

CQ1: Is the proposition presented by the example in fact true?
CQ2: Does the example support the general claim it is supposed to be an instance of?
CQ3: Is the example typical of the kinds of cases that the generalization ranges over?

For the purpose of this paper, we do not consider all the 65 argumentation schemes presented by Walton and colleagues [33] since some of them, like for instance the *Argument from Position to Know* deal with argument patterns which involve the information sources. Reasoning about the information sources using argumentation schemes [20] is out of the scope of this paper. Beside the above presented *Argument from Example*, the following argumentation schemes will be the focus of the analysis we carry out in this paper.

Argument from Cause to Effect

Major Premise: Generally, if A occurs, then B will (might) occur.
Minor Premise: In this case, A occurs (might occur).
Conclusion: Therefore, in this case, B will (might) occur.

Argument from Effect to Cause

Major Premise: Generally, if A occurs, then B will (might) occur.
Minor Premise: In this case, B did in fact occur.
Conclusion: Therefore, in this case, A also presumably occured.

Practical Reasoning

Major Premise: I have a goal G.
Minor Premise: Carrying out action A is a means to realize G.
Conclusion: Therefore, I ought (practically speaking) to carry out this action A.

Argument from Inconsistency

Premise: If a is committed to proposition A (generally, or in virtue of what she has said in the past)
Premise: a is committed to proposition $\neg A$, which is the conclusion of the argument α that a presently advocates.
Conclusion: Therefore, a's argument α should not be accepted.

Argumentation schemes have been used in the Araucaria system [29] to mark instantiations of such schemes explicitly, providing in this way an online repository of arguments.[1] This annotated corpus contains approximately 600 arguments, manually annotated, extracted from various sources such as the US Congress Congressional Record, and the New York Times. Although, up to our knowledge, Araucaria is the best argumentation corpus available to date, it still has some drawbacks. First, Araucaria is rather small if compared for instance with the PDTB. Moreover, given that the final aim of this paper is to bridge discourse in NLP and argumentation schemes, we need a corpus like the PDTB, which is a well-established, standard reference in NLP and where the discourse relations are already annotated.

[1] `http://araucaria.computing.dundee.ac.uk/`

3 Discourse Analysis and the Penn Discourse Treebank

In Linguistics, discourse analysis is a broad term used to cover linguistic phenomena occurring beyond the sentence boundary, usually emerging from corpus evidence. Several paradigms have been proposed to approach discourse analysis from a computational point of view, from Hobb's theory on inference types [17] to Grosz and Sidner's [15] recursively defined relations between units of structure called *discourse segments*. A discourse theory which has gained popularity in the natural language processing community is the Rhetorical Structure Theory [18], which represents texts as trees whose leaves are elementary discourse units and whose nodes specify how these and larger units are linked to each other by rhetorical relations (e.g. contrast, elaboration, etc.). In the Penn Discourse Treebank project [23], instead, no assumption is made about the hierarchy of the relations and the overall structure of a text, and the analysis is focused on the single relations holding between two text spans. Given the simplicity of the annotation scheme, the availability of a large annotated corpus and the attempt to be as much theory-independent as possible, we select the PDTB for our comparison to argumentation schemes. It is a resource built on top of the Wall Street Journal corpus (WSJ) consisting of a million words annotated with discourse relations by human annotators. Discourse connectives are seen as discourse predicates taking two text spans as arguments, that correspond to propositions, events and states.

In the PDTB, relations can be explicitly signaled by a set of lexically defined connectives (e.g. "because", "however", "therefore", etc.). In these cases, the relation is overtly marked, which makes it relatively easy to detect using NLP techniques [21]. A relation between two discourse arguments, however, does not necessarily require an explicit connective, because it can be inferred also if a connective expression is missing. These cases are referred to as *implicit relations*, and in the PDTB they are annotated only between adjacent sentences within paragraphs. In case the connective is not overt, PDTB annotators were asked to insert a connective to express the inferred relation.

The abstract objects involved in a discourse relation are called `Arg1` and `Arg2` according to syntactic criteria and each relation can take two and only two arguments. Example 1 (a)-(b) represents sentences connected, respectively, by an explicit and an implicit relation. `Arg1` and `Arg2` are reported in italics and in bold respectively.

Example 1

(a) Explicit: *The federal government suspended sales of U.S. savings bonds* <u>because</u> **Congress hasn't lifted the ceiling on government debt.**

(b) Implicit: *The projects already under construction will increase Las Vegas's supply of hotel rooms by 11,795, or nearly 20%, to 75,500.* **By a rule of thumb of 1.5 new jobs for each new hotel room, Clark County will have nearly 18,000 new jobs**.

While in Example 1(a) the connective "because" explicitly signals a causal relation holding between `Arg1` and `Arg2`, in (b) no connective was originally expressed. A consequence relation is inferred between '*the increase in the number of rooms*' and '*the increase in the number of jobs*', though no *explicit* connective expresses this relation.

Each discourse relation is assigned a sense label based on a three-layered hierarchy of senses. The top-level, or *class level*, includes four major semantic classes, namely

TEMPORAL, CONTINGENCY, COMPARISON and EXPANSION. For each class, a more fine-grained classification has been specified at *type* level, as shown in Figure 1. For instance, the relation in Example 1(a) belongs to the CONTINGENCY class and the *Cause* type. A further level of *subtype* has been introduced to specify the semantic contribution of each argument. *Cause*, for instance, comprises the *reason* and the *result* subtypes. The former applies when the situation described in `Arg2` is the cause of the situation in `Arg1`, like in Example 1 (a), while the latter indicates that the situation in `Arg2` is the result of the situation in `Arg1`. The annotation scheme was developed and refined by the PDTB group in a bottom-up fashion, following a lexically grounded approach to annotation.

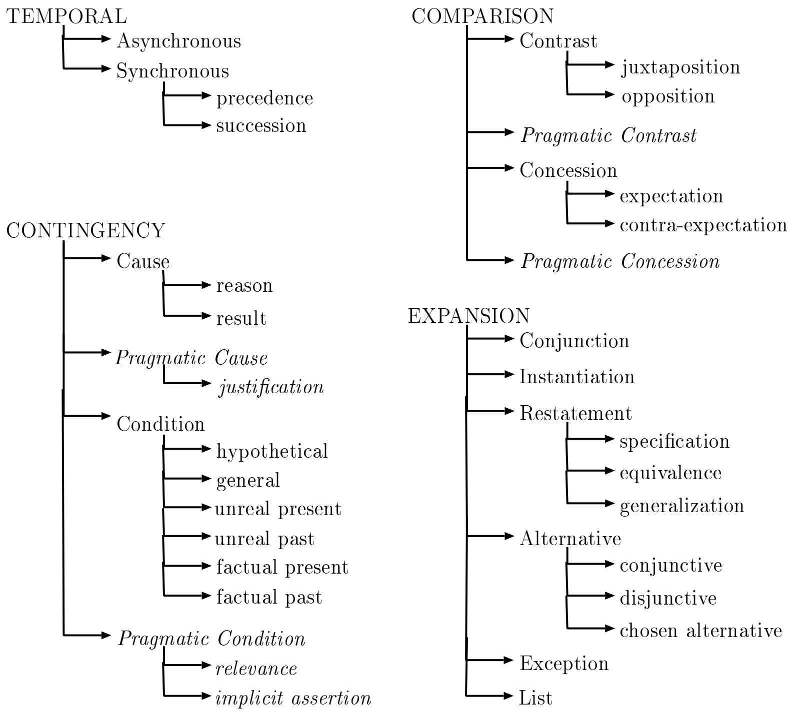

Fig. 1. Sense tags [The PDTB Research Group, 2008]

While in the PDTB they avoid considering the arguments as "logical arguments", for convention in our work we represent them in the standard format of a logical argument, where `Arg1` is a (set of) premise(s), and `Arg2` is the conclusion.

4 From Argumentation Schemes to Discourse Relations and Back

In this section, we position and analyze the work carried out in the computational linguistics field on discourse analysis, under the perspective of argumentation schemes.

We rely on the Penn Discourse Treebank (Section 3) as the reference resource of natural language text annotated with discourse relations. In particular, in Section 4.1 we start from the argumentation schemes, and we analyze how they fit into the categories of the discourse relations in PDTB. Examples in natural language support us in bringing to light the similarities and the discrepancies between the classifications sketched by the two research fields. From the opposite perspective, in Section 4.2, we first account for the PDTB categories of relations that we have not included in our analysis, and we further highlight the emergence of additional argumentation schemes from such natural language data.

4.1 From Argumentation Schemes to PDTB

In the following, we investigate how the argumentation schemes described in [33] and detailed in Section 2 fit into the discourse relations in PDTB.

We start our analysis from a theoretical viewpoint, comparing the definitions of the argumentation schemes as provided in [33], with the definitions of the discourse relations as provided in [The PDTB Research Group, 2008], to build our mapping hypothesis. We then randomly choose 10 examples for each (or each group of) discourse relation we associate with an argumentation scheme according to their definitions, to create a dataset of 50 examples to evaluate our mapping assumptions. Two annotators with skills in linguistics independently annotated the whole set of examples, according to the following tags: *i)* `YES`, if the structure and the reasoning type of the argument extracted from the PDTB correspond to the argumentation scheme to which they were previously associated in our working hypothesis (e.g. if the argument from the category EXPANSION:*Restatement*:"generalization" represents an instantiation of the argumentation scheme *Argument from Example*); *ii)* `NO`, if the structure and the reasoning type of the argument extracted from the PDTB do not correspond to the argumentation scheme to which they were previously associated; *iv)* `INCORRECT`, in case the argument extracted from the PDTB is incomplete and not understandable when out of context. To assess the validity of the annotation task (and therefore the reliability of our argumentation scheme/PDTB relations mapping), we compute the *inter-annotator agreement*, based on the annotations separately provided by the two annotators on the same sample of 50 argument pairs. The statistical measure usually used in NLP to calculate the inter-rater agreement for categorical items is Cohen's kappa coefficient [6], that is generally thought to be a more robust measure than simple percent agreement calculation since κ takes into account the agreement occurring by chance. More specifically, Cohen's kappa measures the agreement between two raters who each classifies N items into C mutually exclusive categories. The equation for κ is:

$$\kappa = \frac{\Pr(a) - \Pr(e)}{1 - \Pr(e)} \tag{1}$$

where Pr(a) is the relative observed agreement among raters, and Pr(e) is the hypothetical probability of chance agreement, using the observed data to calculate the probabilities of each observer randomly saying each category. If the raters are in complete agreement then $\kappa = 1$. If there is no agreement among the raters other than what would be expected by chance (as defined by Pr(e)), $\kappa = 0$. For NLP tasks, the inter-annotator agreement is considered as significant when $\kappa > 0.6$. Applying the formula (1) to our data, the inter-annotator agreement results in 0.71 (while the percentage of agreement between the two annotators is 88%). As a rule of thumb, this is a satisfactory agreement, confirming the reliability of the obtained resource, and the validity of the task.

The examples extracted from the PDTB for some categories of discourse relations perfectly represent instantiations of the argumentation schemes (e.g., the discourse relation EXPANSION:*Restatement*:"generalization" fits into the argumentation scheme *Argument from Example*). On the contrary, for some other schemes the mappings with discourse relations are much less straightforward, even if the relation definitions in the PDTB and the provided schemes are similar (see the PDTB Manual [31]).

Argument from Example. As introduced before, such argumentation scheme is used to support some kinds of generalization. Its definition shows high similarity with the discourse relation EXPANSION:*Restatement*:"generalization". More specifically, "generalization" applies when the connective indicates that `Arg2` (i.e. the conclusion) summarizes `Arg1` (the premises), or in some cases expresses a conclusion based on `Arg1` (as in Example 2). Differently from the argumentation schemes, where the standard format allows *therefore* as the only connective used to introduce the conclusion, in natural language different connectives can be used with the same goal, and can vary according to the discourse relations they express. For instance, typical connectives for generalization are *in sum*, *overall*, *finally*.

Example 2 (generalization)

PREMISE: `(Arg1)` While the network currently can operate freely in Budapest, so can others
CONCLUSION: **indeed** `(Arg2)` Hungary is in the midst of a media explosion.

Example 2 can be considered as a good instantiation of the *Argument from Example* scheme, since given the property defined in the premise for a town (i.e. the good quality of the network status), the conclusion is inferred generalizing such property to the whole country. On the contrary, several PDTB examples for this relation, i.e. EXPANSION:*Restatement*:"generalization" were annotated as negative examples by the annotators, due to the fact that in many cases the conclusion is a sort of motto, as in Example 3, or a metaphor.

Example 3 (generalization)

PREMISE: `(Arg1)` It's time to take some risks if you want the kind of returns that will buy your toddler a ticket to Prestige U. in 18 years
CONCLUSION: **in short** `(Arg2)` throw away the passbook and go for the glory.

In general, both for this argumentation scheme, and for the following (i.e. *Argument from Cause to Effect* and *Argument from Effect to Cause*), the mappings with the categories of the discourse relations detected in the PDTB are straightforward (on the *Argument from Example* scheme, the agreement between annotators is 100%), and the positive examples collected can be fruitfully considered as examples of naturally occurring schemes in texts, as opposed to ad-hoc examples that can be found in most of the literature on argumentation theory.

Argument from Cause to Effect and from Effect to Cause. These two argumentation schemes are reported here in the same paragraph, since the underlying reasoning steps address, in a sense, opposite perspectives. More precisely, the *Argument from Cause to Effect* is a predictive form of reasoning that reasons from the past to the future, based on a probabilistic generalization. On the contrary, the *Argument from Effect to Cause* is based on a retroduction, from the observed data to a hypothesis about the presumed cause of the data (abductive reasoning) [33]. Comparing these definitions with the definitions provided for the discourse relations in the PDTB, we can note that they are highly similar with the discourse relation: CONTINGENCY:*cause*, identified when the situations described in `Arg1` and `Arg2` are causally influenced, and the two are not in a conditional relation. Directionality is specified at the level of subtype: "reason" (($\|\texttt{Arg2}\| < \|\texttt{Arg1}\|$[2], see Example 4) and "result" ($\|\texttt{Arg1}\| < \|\texttt{Arg2}\|$, see Example 5) specifying which situation is the cause and which is the effect. Both subtypes can be respectively mapped to the argumentation schemes *Argument from Effect to Cause*, and *Argument from Cause to Effect*. In the former (i.e."reason") the connective indicates that the situation described in `Arg2` is the cause, and the situation described in `Arg1` is the effect. The typical connective for such relation is indeed *because*. On the contrary, for the latter (i.e. "result") , the connective indicates that the situation described in `Arg1` is the reason, and the situation described in `Arg2` is the result. Typical connectives are *so that*, *thefore*, *as a result*.

Example 4 (reason)

CONCLUSION: (`Arg1`) She pleaded guilty.
PREMISE: **because** (`Arg2`) she was afraid of further charges

Example 5 (result)

PREMISE: (`Arg1`) Producers were granted the right earlier this year to ship sugar and the export licenses were expected to have begun to be issued yesterday
CONCLUSION: **as a result** (`Arg2`) it is believed that little or no sugar from the 1989-90 crop has been shipped yet

Note that, due to the variability of language, the sequence of premises and conclusion in NL arguments does not always follow the order defined in the standard structure (where premises always come first), as e.g. in Example 4, where the conclusion is expressed at the beginning of the sentence. In the same example, the reasoning is carried out from effect to cause (i.e. the fact that she was afraid of further charges, generates the woman's reaction of declaring herself guilty). On the contrary, in Example 5, the reasoning is carried out from cause to effect (i.e. the fact that licenses were expected

[2] The symbol $<$ used in the PDTB categories means "causes".

to have been issued the day before - but it did not happen - let to conclude that the sugar has not been shipped yet). In our dataset, 80% of the examples collected from the PDTB relations *Reason* and *Result* are annotated as positive instantiations of the *Argument from Cause to Effect* and *from Effect to Cause* schemes.

So far so good. As introduced before, the mapping of the above described types of argumentation schemes is pretty straightforward, and the examples collected in the PDTB generally fall within the definitions of such schemes provided in [33]. In the following, we enter into a grey area, where the mapping between the argumentation schemes and the categories of the discourse relations is more blurry, and the examples collected in the PDTB do not always represent correct instantiations of such schemes. But since the goal of our work is to investigate all the possible connections between the two research fields, we force the hand of the mapping, allowing us some simplifications.

Practical Reasoning. This argumentation scheme involves the general human capacity for resolving, through reflection, the question of what one is to do, given the goal that one has in mind. To fit such scheme into one discourse category, we need therefore to consider a relation that relies on some kind of pragmatic reasoning, and on common background knowledge. For this reason, we think that the most appropriate relation annotated in the PDTB is the CONTINGENCY:*Pragmatic condition*, used for instances of conditional constructions whose interpretation deviates from that of the semantics of *Condition*. In all cases, `Arg1` holds true independently of `Arg2`. The conditional clause in the “relevance” conditional (`Arg2`, i.e. the premise) provides the context in which the description of the situation in `Arg1`, i.e. the conclusion, is relevant (see Example 6). There is no causal relation between premises and conclusion.

Example 6 (relevance)

PREMISE (`Arg1`): here’s the monthly sum you will need to invest to pay for four years at Yale, Notre Dame and University of Minnesota
PREMISE : **if** (`Arg2`) you start saving for your child’s education on Jan. 1, 1990

In Example 6 the major premise, i.e. the goal, is implicit (i.e., enthymeme [33]), and concerns the child education (in other words, the goal is to send the child to one of the best U.S. universities). The other two premises (i.e. `Arg2` and `Arg1`) describe the action to be carried out to obtain the goal (i.e. given the amount of money you need, you can have it if you start saving from the beginning of 1990). Following the scheme’s structure, also the conclusion is left implicit (i.e. *therefore, if you want to reach your goal, you should start saving*). Another interesting observation emerging from naturally occurring data is the fact that in human linguistic interactions a lot is left implicit, following [14]’s conversational *Maxim of Quantity* (i.e. do not make your contribution more informative than is required).

The tag “implicit assertion” applies in special rhetorical uses of if-constructions when the interpretation of the conditional construction is an implicit assertion.

Example 7 (implicit assertion)

PREMISE: **if** (`Arg2`) you want to keep the crime rates high
CONCLUSION (`Arg1`): O'Connor is your man

In Example 7 the conclusion, i.e. *O' Connor is your man*, is not a consequent state that will result if the condition expressed in the premise holds true. Instead, the conditional construction in this case implicitly asserts that O'Connor will keep the crime rates high (enthymeme), and requires a pragmatic reasoning step. For both subtypes, the typical connective expressing the discourse relation is *if*. In our dataset, 70% of the examples collected from the PDTB relation CONTINGENCY:*Pragmatic condition* are annotated as positive instantiations of the *Practical reasoning* argumentation scheme.

Argument from Inconsistency. The last argumentation scheme we consider in our inspection is the *Argument from Inconsistency*, where the inconsistency can be detected in an arguer's commitment set. Even if the mapping of such scheme with one of the discourse categories is far from being straightforward, after a careful analysis of both the definitions and the examples in the PDTB, we consider that the relation COMPARISON:*concession*, that applies when one of the arguments describes a situation A which causes C, while the other asserts (or implies) ¬C, seems to fall within such scheme. Alternatively, the same relation can apply when one premise denotes a fact that triggers a set of potential consequences, while the other denies one or more of them, and still in this case it fits with the definition of the above mentioned argumentation scheme. Formally, we have $A < C \wedge B \rightarrow \neg C$, where A and B are drawn from $\|\texttt{Arg1}\|$ and $\|\texttt{Arg2}\|$ ($\neg C$ may be the same as B, where $B \rightarrow B$ is always true). Two *concession* subtypes are defined in terms of the argument creating an expectation and the one denying it. Specifically, when `Arg2` creates an expectation that `Arg1` denies ($A = \|\texttt{Arg2}\|$ and $B = \|\texttt{Arg1}\|$), it is tagged as *expectation* (see Example 8). When `Arg1` creates an expectation that `Arg2` denies ($A = \|\texttt{Arg1}$ and $B = \|\texttt{Arg2}\|$), it is tagged as *contra-expectation* (see Example 9).

Example 8 (expectation)

PREMISE (`Arg1`): Attorneys for the two sides apparently began talking again yesterday in attempt to settle the matter before Thursday
PREMISE: **although** (`Arg2`) settlement talks had been dropped

Example 9 (contra-expectation)

CONCLUSION: (`Arg1`) The demonstrators have been non-violent
PREMISE: **but** (`Arg2`) the result of their trespasses has been to seriously impair the rights of others unconnected with their dispute

In Example 8 we start from the evidence provided by the premise according to which the settlement talks between the attorneys have started, and we are pushed to conclude that they are still going on, while the conclusion provided by the arguer is inconsistent (i.e. settlement talks had been dropped). With the same reasoning step, in Example 9 we expect that no bad consequences are caused by the demonstrators thanks to their pacific attitude, but our expectation is wrong. In our dataset, 60% of the examples collected from the PDTB relation *expectation* and *contra-expectation* are annotated as positive instantiations of the *Argument from Inconsistency* scheme. In general, the 12% of the examples of the dataset (i.e. 6/50) were annotated as `INCORRECT` by the annotators (i.e. incomplete arguments, and/or not understandable when out of context).

We report in Table 1 some statistics on the PDTB relations considered in our study. We extract them from the PDTB and report the total number of examples both of *implicit* and *explicit* relations (the 50 examples of our dataset were extracted from the explicit relations only, the analysis of implicit relations is left for future work). Since PDTB annotators were allowed to assign more than one relation label, we report only the relations whose *first* label is the one reported in the first column. Also, we consider only the examples in which `Arg2` is not embedded in `Arg1` (more than 90% of the overall examples), because we want to avoid that premises and conclusions according to argumentation schemes are expressed by discontinuous arguments. Next to each discourse subtype, we also list the three most-frequent connectives occurring in the *explicit* relations (for *Relevance*, only two connectives are found in the examples). This confirms that, although *therefore* is the only connective usually employed in argumentation schemes to introduce the conclusion, corpus-based analysis shows a higher variability and a much richer repository of admissible connectives.

Table 1. Statistics about the extracted examples

Relation class.Type *Subtype* ('most-frequent connectives')	Num. Expl.	Num. Impl.
Expansion.Restatement		
Generaliz. ('in short', 'in other words')	16	190
Contingency.Cause		
Reason ('because', 'as', 'since')	1,201	2,434
Result ('so', 'thus', 'as a result')	617	1,678
Contingency.Pragm.Condition		
Relevance ('if', 'when')	21	1
ImplicitAssertion ('if', 'when', 'or')	46	0
Comparison.Concession		
Expectation ('although', 'though', 'while')	386	31
ContraExpectation ('but', 'still', 'however')	798	182

Notice that we do not tackle the issue of dealing with enthymemes and implied assertions. Whilst human annotators can deal with this problem to an acceptable extent, identifying suitable markers to indicate the occurrence of such instances is a problem. Similar issues are reported in those works in which natural language texts are analyzed to produce instantiations of an argumentation scheme for an e-Participation tool. For instance, Pulfrey-Taylor et al. [24] report upon the instantiation of a scheme for practical reasoning with values, based upon responses to an EU green paper, and discourse indicators have also been used to annotate text to instantiate argumentation schemes in an e-Commerce corpus by Wyner et al. [36].

4.2 From PDTB to Argumentation Schemes

We have not included other PDTB relations in our analysis, either because they do not fall within the definition of arguments as provided in argumentation theory, or because no argument scheme accounts for them.

As introduced before, in our work we consider the set of discourse relations that better fall into the structure defined for the argumentation schemes. Other categories of discourse relations, e.g. the EXPANSION:*Alternative*, or *List* are not considered because they do not fall within the definition of arguments as provided in argumentation theory (i.e. they do not allow us to carry out a reasoning step), and can be more considered as claims or statements.

We propose now two additional argumentation schemes which emerge from the discourse relations in the PDTB. In particular, concerning the PDTB relations EXPANSION:*Restatement*:"equivalence", and EXPANSION:*Restatement*:"specification" we do not find an argumentation scheme actually fitting the argument pattern expressed by these relations. Even if the *Argument from Analogy* scheme [33] seems close to the equivalence relation, their semantics is slightly different: the former expresses that two cases are similar and that if A is found true in one case, then it is true also in the other case. The latter expresses that if a situation occurs, and this situation is known as equivalent to another one, then the second situation occurs too. The *Argument from Equivalence* is formalized below.

Argument from Equivalence

Premise: A occurs.
Premise: A is equivalent to B.
Conclusion: Therefore, also B occurs.

This argumentation scheme is instantiated in Example 10 extracted from the PDTB, where the premise provides an evidence about a fact (i.e. price augmentation), while in the conclusion the same fact is considered from a different viewpoint, showing the consequent currency depreciation.

Example 10 (equivalence)

PREMISE (`Arg1`): On average, something that cost $100 30 years ago now costs $425
CONCLUSION: **or** (`Arg2`) a wage that was $100 30 years ago would buy only $23.53 worth of stuff today

The second argumentation scheme we introduce is called *Argument from Specification* and it is formalized below. It specifies a kind of abductive reasoning such that a situation A occurs, and in the particular case of interest this means that a more specific situation B is a subclass of A, therefore more precisely B occurs. The basic idea here is that a particular situation is a specification of another situation, and it is in fact this more specific situation which occurred.

Argument from Specification

Premise: Generally, A occurs.
Premise: In this particular case, B is a subclass of A.
Conclusion: Therefore, more precisely, B occurs.

This argumentation scheme is instantiated in Example 11. In the premise, the general economical situation is not seen as rosy, while an implicit premise provides an evidence to support the fact that the steelmakers are part of the economic world and are influenced from its trend. An inferential step about the bad economical forecasts is further specified for that specific category in the conclusion.

Example 11 (specification)

PREMISE (`Arg1`): It doesn't bode well for coming quarters
CONCLUSION: **in fact** (`Arg2`) several steelmakers will report actual losses through the third quarter of 1990

In this section we have proposed two additional argumentation schemes, namely *Argument from Equivalence* and *Argument from Specification*, which emerge from the discourse relations highlighted in the PDTB. The rationale behind this kind of additional schemes is that two discourse relations as the EXPANSION:*Restatement*:"equivalence", and the EXPANSION:*Restatement*:"specification" cannot be mapped with the existing argumentation schemes as done for the schemes we presented in the previous section, but they lead to a reasoning step. We are aware that new argument schemes should be proposed only as a last resort since there is already a proliferation of such patterns, which often impairs their practical usefulness. However, it is actually the practical usefulness which guides the introduction of such new schemes which are *existing* schemes emerging from a real world corpus of natural language arguments. To conclude, we underline the importance of more "practical" argumentation schemes like those which could emerge from large corpora of NL arguments, even if we are aware of the remark about the proliferation of new schemes. To this concern, we may align the new argumentation schemes with existing ones (e.g., *Argument from Equivalence* aligned with *Argument from Definition*) even if the alignment may not be consistent in all real world examples concerning the above mentioned discourse relations.

5 Related Work

The need for coupling argumentation theory and NLP is becoming more and more important in the latest years, as shown by the increasing number of online debate systems like Debategraph[3] and Debatepedia[4]. The need for a machinery leading to arguments being automatically generated is underlined also by Grasso and colleagues [13,26].

Some approaches have been proposed to address this issue in the two research communities. For instance, Chasnevar and Maguitman [7] propose a defeasible argumentation system to provide recommendations on language patterns to assist the language usage assessment. The indices they use are computed from Web corpora.

[3] `http://debategraph.org`
[4] `http://dbp.idebate.org/`

Gilbert [10] addresses the problem of characterizing human/computer argumentation, where the ability to identify and classify various locutions as facts, values and goals is discussed, and the author chooses Toulmin's argumentation model [32] for his analysis.

Wyner and van Engers [34] propose to couple NLP and argumentation to support policy makers. The NLP module guides the user in writing the input text using Attempt to Controlled English allowing for a restricted grammar and vocabulary, and after a parsing step, the sentences are translated to First Order Logic. In this paper, we do not look for a translation in formal logic of NL arguments, but we are interested in the structure of the arguments such as in argumentation schemes, where the relation among the premises and the conclusion is represented through the discourse relations of the PDTB.

Cabrio and Villata [4] propose to use the NLP framework of textual entailment to extract from Debatepedia the arguments in NL and the relations among them. Then, the arguments are composed in a Dung-like [8] abstract argumentation framework to select the acceptable arguments. The authors look only at the relations among the arguments, while here we are most interested in the relation among premises and conclusion in NL arguments.

Carenini and Moore [5] present a computational framework for generating evaluative arguments. We use a different model of arguments, i.e., argumentation schemes, and we do not provide an automatic system for argument generation.

Amgoud and Prade [1] start from a model of argumentation presented in linguistics [2] and try to formalize it using formal argumentation. They envisage a comparison with argumentation schemes as future work. In this paper, we consider only such schemes to provide the parallel with NLP.

The difference with respect to this line of works is that they do not consider arguments as composed by a set of premises and a conclusion as done in argumentation schemes where the relation among these two kinds of elements is characterized in terms of *practical reasoning*, etc. In this paper, we address the problem of coupling two distinct research areas, namely discourse analysis in NLP and argumentation schemes in informal logic to better understand, over a real world set of examples (the PDTB), how discourse relations can be used towards the automatic detection of argumentation schemes in natural language texts.

The work which is most related to this paper is the following. Feng and Hirst [9] present an automatic system for classifying the argumentation schemes of NL arguments with the aim to infer enthymemes. The data set they use is the Araucaria one. Our analysis can be used to support this kind of automated classification task thanks to the mapping with the discourse relations we provide, and the resulting annotated arguments corpus can be used for training. Using automated approaches to classify argumentation schemes and infer enthymemes is the next step in our work.

6 Concluding Remarks

We presented an analysis of the connections between two distinct research areas, namely discourse analysis in natural language processing, and argumentation schemes in argumentation. Following the idea of focusing first on models of natural language schemes and then building formal systems [27], the rationale behind this kind of analysis is to provide a first, but compulsory step towards the development of automatic techniques able to deal with the complexities present in natural language arguments. Even if recent approaches like [26,4,35,1] provide a first attempt to tackle the open problem of natural language argumentation, they show that a satisfiable result is still far beyond. As demonstrated in this paper, the development of automated systems going beyond applications like the one proposed by Cabrio and Villata [4], where only two relations among the arguments are considered and arguments are abstract, is much more complex.

Our future work includes the design and implementation of an automated framework able to detect not only the abstract arguments from natural language text, but also their internal structure [27,22] with the aim to verify the coherence of such arguments before considering the (eventual) relations with the other arguments. The bridge with discourse analysis, enables us to carry out an in-depth study of the argument structures, relying on the data previously annotated with discourse relations, and now annotated also with the corresponding argumentation schemes. As an additional outcome of our work, we will soon release the annotation of the PDTB examples with the considered argumentation schemes, that can be fruitfully exploited as a training corpus in NLP applications.

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