Argumentation Schemes as Templates? Combining Bottom-up and Top-down Knowledge Representation

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Abstract. This paper describes a long-term research goal which aims at creating a middleware interface between Argumentation Schemes and natural language. This idea comes from the need to face some challenges related to the automatic extraction of Argumentation Schemes from Natural Language: for example the ability to extract Argumentation Schemes at different level of granularity. In the paper we describe how this process can be designed and how the structures of Argumentation Schemes can be modeled to this aim.

Keywords: Argumentation schemes · Knowledge representation · Argument mining

1 Introduction

Argumentation Schemes are stereotypical patterns of argumentative inferences [9] commonly employed by humans in the formulation of natural arguments and famously formalized in [12]. These patterns are an ongoing effort of categorization which has been increasingly investigated from different perspectives in the last few decades: not only from a philosophical point of view [9, 12], but also from a computational point of view [2, 5, 7]. A major reason for this interest has been the rise of Argument Mining, which focuses on the extraction, classification and analysis of argumentative data [8].

On the one side, Argumentation Schemes are important source of information for Argument Mining. On the other side, however, the automatic extraction of Argumentation Schemes (or their inner components) has been attempted only in few studies [2, 5, 6] and the ability to leverage the argumentative knowledge provided by Augmentation Schemes is still largely to be exploited. In this paper, we will present a long-term research goal, offering a potential direction to achieve this objective of leveraging the potential of Argumentation Schemes in terms of knowledge representation and in terms of reasoning.

Section 2 will describe the motivations behind this study. Section 3 will describe the main idea of this study: the combination of a top-down and a bottom-up approach to exploit Argumentation Schemes' potential. Section 4 will describe some related works. Section 5 will conclude the paper.

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2 Motivations

Argumentation Schemes are stereotypical patterns of inference [9] which can be formulated in different ways by using different pieces of natural language. These patterns convey important argumentative knowledge, showing typical ways in which people reason and argue. On the one side, they describe premises and conclusions that people commonly employ in certain scenarios, providing a crucial connection between a quasi-logical inferential sphere and natural language. On the other side, they offer a way to evaluate the reasoning, because a set of Critical Questions is attached to each scheme to assess its strength. These two sides show that Argumentation Schemes can be valuable tools not only for Argument Mining (e.g., extracting arguments) but also for Formal Argumentation (reasoning automatically from textual data). In this regard, a long-term goal is to recognize Argumentation Schemes automatically from natural language, at various degrees of granularity (clustering schemes), and to automatically recognize their inner components, i.e. their premises and conclusions, in order to apply formal reasoners (formal structured argumentation).

On the one side, a major obstacle is the fact that every-day natural language (like the one employed on internet comments or posts) has a very complex and variable ontological dimension; furthermore, it is often inferentially incomplete (information is often implicit or even incoherent). These two elements, i.e. *ontological complexity* and *inferential incompleteness*, can make it difficult to understand what schemes are actually employed in natural language. On the other side, Argumentation Schemes can offer a valuable interface between natural language and reasoning. In fact, they involve just a restricted ontological dimension (which is, however, too simple to catch all the possible expressions of the same scheme within human language). Moreover, they convey enough (although sometimes incomplete) inferential information to perform a formal evaluation on the argument. Argumentation Schemes offer, thus, a different scenario compared to every-day natural language: they are *ontologically too simple* and, potentially, they are *inferentially incomplete*.

These differences between natural language and Argumentation Schemes regarding the ontological and the inferential dimensions, are the reason why it is difficult to leverage Argumentation Schemes knowledge directly from textual data. The long-term goal described in this paper is to create middleware inferential-ontological interfaces (called Argumentation Scheme Templates) where natural language complexity can be safely compressed, while Argumentation Scheme simplicity can be safely extended. We argue that the solution might be that of combining a top-down approach (from the layer of abstraction of Argumentation Schemes towards natural language) with a bottom-up approach (from natural language toward the layer of abstraction of Argumentation Schemes). The former aims at creating Argumentation Schemes templates (which can be designed to represent clusters of schemes with a variable degree of granularity). The latter aims at mapping pieces of natural language to the inner components of these templates (i.e., mapping natural language premises and conclusions to the templates' components).

3 Towards Argumentation Schemes Templates

This approach is described in Figure 1 and can be summarized in four points, two related to the top-down approach and two related to the bottom-up approach. Starting from the top-down, the first aspect to consider is that the middleware templates should preserve all the ontological information of the original Argumentation Scheme. Usually schemes use stereotypical semantic-ontological expression, for example the first premise of the Argument from Negative Consequences says that "if A is brought about, bad consequences will plausibly occur": this causal relation should be somehow represented in the template, as well as the entities which are pragmatically crucial for the scheme, i.e. an entity *action* ("A") and an entity *outcome* ("bad consequences"). A second aspect to consider is that, since Argumentation Schemes often represent stereotypical and incomplete ways of reasoning, the crucial inferential steps that are missing or implicit should be added. For example, taking in consideration the previous premise from the Argument from Negative Consequences, and its relative conclusion "Therefore A should not be brought about", one should notice that there is a missing inferential step: the warrant is missing (namely, the fact that whenever an action has negative consequences such action should not be brought about); the final template must have a component for this missing inferential step. Table 1 provides a potential resulting template for the Negative Consequences scheme.

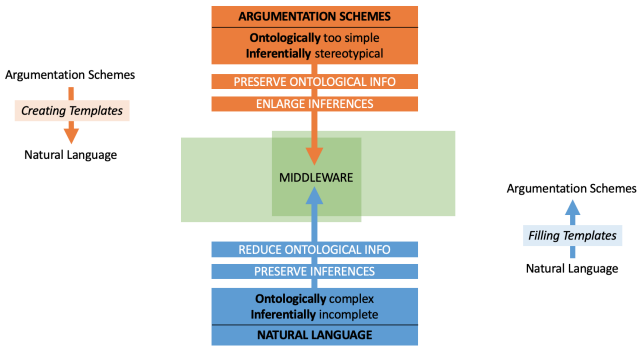

Fig. 1. The long-term goal of combining a bottom-up and a top-down approach.

Regarding the bottom-up approach, the first aspect to consider is that we need to build classifiers able to map (i.e., reduce) the complexity of natural language into the components of the Argumentation Schemes Template. For example, we can consider a Negative Consequences scheme like the sentence "Sending troops would provoke a war, so I think we should absolutely avoid it", our classifiers should be capable of mapping the piece "Sending troops would provoke a war" into the first component of the Template of the scheme from Negative Consequences described in Table 1: $doing(Action(\text{"Sending troops"})) \xrightarrow{\text{causes}}$

$OutcomeNegative$("war")). Similarly, the conclusion "so I would absolutely avoid it" might be designed as $\neg isWanted(Action(\text{"Sending troops"}))$. Finally, a fourth element to consider is the fact that the ontological complexity of the original sentence will be compressed into the standard representative expressions of the chosen language. This point is crucial because Argumentation Schemes Templates should use a language which is carefully designed following pragmatics: for example, we chose functions like "doing", "isWanted" and entities like "Action" and "OutcomeNegative" because the pragmatic sphere of this Argumentation Scheme reasons about the goodness of doing or not an action. In this sense, pragmatics can guide us into the design of the language.

Table 1. Argumentation Scheme Template for the Negative Consequences scheme (the hidden warrant is made explicit).

Major Premise	$doing(Action(A)) \overset{\text{causes}}{\Longrightarrow} OutcomeNegative(G)$
Hidden Premise	$\neg isWanted(OutcomeNegative(G))$
Conclusion	$\therefore \neg isWanted(doing(Action(A)))$

We designed $\neg isWanted$ as the negation of a Defeasible Modus Tollens (DMT) in which the inferential negation ($\neg$) is intertwined with the semantical-ontological sphere ($isWanted$): the DMT makes it possible that the negation $\neg isWanted$ goes from the consequent $OutcomeNegative(G)$ to the antecedent $doing(Action(A))$. This is how the ontological and the inferential dimension are intertwined, and why we envisage a language which can express this overlapping.

While some limitations of employing First-Order Logic languages to model Argumentation Schemes have been rightly remarked in [3] (e.g., the presence of second-order variables) the design of the language and the choice of what logical family is more appropriate depend on the needed degree of expressiveness. To understand what is the right degree, we might consider the following features of schemes: their logical patterns, the entities involved in their inferential path, the semantic and ontological relations among entities, the Critical Questions. Regarding the first ones, we agree with the hypothesis in [12] and [9], according to which Argumentation Schemes follow defeasible logical patterns such as Defeasible Modus Ponens and Defeasible Modus Tollens. As previously discussed with the warrant of the Negative Consequence scheme, these patterns can be found behind the missing inferential steps. Regarding entities, the language should be designed to include the basic classes of entities involved in the inferential process (e.g., Action), and it might also include the ontological relations among them (e.g., OutcomeNegative might be a sub-type of a class Outcome and the opposite of the class OutcomePositive). A final aspect is related to Critical Questions. Those that imply undercuts or rebuttals do not need to be included in templates (because they just show what part of the template might be attacked or "stressed"). However, according to [11], there are other two kind of Critical Questions which show, respectively, exceptions and conditions to the applicabil-

ity of their scheme: we think that these two kinds of Critical Questions might be included in the templates as additional components.

For the bottom-up approach, we envisage a combination of text classification and sequence labelling tasks. Text classification tasks can be used to cluster schemes while sequence labelling tasks can be used to select the spans of text that correspond to portions of template. However, the specifications of the bottom-up approach (filling templates) will necessarily depend on the specifications of the top-down procedure (creating templates).

4 Related Works

The studies which approached the task of extracting Argumentation Schemes automatically resorted to highly engineered methodologies [2] [5], reaching some encouraging results. However, it seems that these classifiers consider only a restricted number of schemes, which are very different among them. It is not clear if they can provide more granular classifications or more border-line classifications. The problem of being able to classify Argumentation Schemes at different degrees of granularity has been partially tackled by some recent studies which attempted to classify Argumentation Schemes' inner components by leveraging structural information [6] [7]. Also in this case, results are encouraging; however, it is not clear if this approach can be extended to other schemes. Importantly, all these studies do not provide any direct interface for artificial reasoners. Which makes the task of applying automatic reasoner to textual data hard to achieve.

While a crucial effort towards a high-level ontology has been provided by AIF [1] and some important studies focused on Argumentation Schemes [10], the inner components of Argumentation Schemes (i.e. premises, conclusions) have been mostly considered as black-boxes [4]. We believe that the gap between Natural Language and Argumentation Schemes requires an effort towards the creation of ontological layers operating at lower levels of abstraction, closer to Natural Language. The Argumentation Scheme Templates envisaged in this paper are an attempt to search for a logical-ontological middleware where the complexity of natural language is compressed and the abstraction of Argumentation Scheme is lowered. Although this is a difficult long-term project, we believe it might be a way to fill the mentioned gap, facilitating automatic reasoning on texts, without excluding an integration with the higher ontological layers provided by AIF.

5 Conclusions

In this work, we described a long-term research direction aiming at facilitating the automatic extraction of Argumentation Schemes from textual data and the application of artificial reasoners to natural language (using Argumentation Schemes knowledge). Being able to reason directly from textual data is an extremely challenging objective which is often made complicated by the fact that natural language has a huge ontological complexity and is often inferentially incomplete. In this regard, Argumentation Schemes are an appealing solution to

this problem because they are an interface between natural language (ontologically complex) and the inferential dimension (ontologically very simple).

We shortly introduced a feasible direction to achieve this long-term goal, which envisages the combination of a bottom-up approach with a top-down approach. The former is an effort to design Argumentation Schemes as quasi-logical templates (Argumentation Scheme Templates) composed of a logical language able to preserve the basic inferential and ontological information of schemes while following the pragmatic criteria of the scheme itself. The latter is an effort to create classifiers able to map pieces of natural language into corresponding pieces of an Argumentation Scheme Template. Although this is a long-term goal, we believe that this direction can be valuable, and capable to leverage and maximize the argumentative knowledge conveyed by Argumentation Schemes.

References

1. Chesnevar, C., Modgil, S., Rahwan, I., Reed, C., Simari, G., South, M., Vreeswijk, G., Willmott, S., et al.: Towards an argument interchange format. The knowledge engineering review **21**(4), 293–316 (2006)
2. Feng, V.W., Hirst, G.: Classifying arguments by scheme. In: Proceedings of the 49th annual meeting of the association for computational linguistics: Human language technologies. pp. 987–996 (2011)
3. Gordon, T.F., Friedrich, H., Walton, D.: Representing argumentation schemes with constraint handling rules (chr). Argument & Computation **9**(2), 91–119 (2018)
4. Hamdan, W., Khazem, R., Rebdawi, G., Croitoru, M., Gutierrez, A., Buche, P.: On ontological expressivity and modelling argumentation schemes using cogui. In: International Conference on Innovative Techniques and Applications of Artificial Intelligence. pp. 5–18. Springer (2014)
5. Lawrence, J., Reed, C.: Argument mining using argumentation scheme structures. In: COMMA. pp. 379–390 (2016)
6. Liga, D.: Argumentative evidences classification and argument scheme detection using tree kernels. In: Proceedings of the 6th Workshop on Argument Mining. pp. 92–97 (2019)
7. Liga, D., Palmirani, M.: Detecting "slippery slope" and other argumentative stances of opposition using tree kernels in monologic discourse. In: International Joint Conference on Rules and Reasoning. pp. 180–189. Springer (2019)
8. Lippi, M., Torroni, P.: Argument mining: A machine learning perspective. In: International Workshop on Theory and Applications of Formal Argumentation. pp. 163–176. Springer (2015)
9. Macagno, F., Walton, D., Reed, C.: Argumentation schemes. history, classifications, and computational applications. History, Classifications, and Computational Applications & Reed, C pp. 2493–2556 (2017)
10. Rahwan, I., Reed, C., Zablith, F.: On building argumentation schemes using the argument interchange format. In: Working notes of the 7th workshop on computational models of natural argument (CMNA 2007), Hyderabad (2007)
11. Verheij, B.: Dialectical argumentation with argumentation schemes: An approach to legal logic. Artificial Intelligence and Law **11**(2), 167–195 (Jun 2003)
12. Walton, D., Reed, C., Macagno, F.: Argumentation schemes. Cambridge University Press (2008)