Proposing Attachment Points in Argument Graphs for New Arguments Expressed in Natural Language

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Abstract. Dealing with arguments in a natural debate can profit from formal representation techniques – in order to facilitate the inspection of their role and interrelations and even reasoning support to determine the state of sets of arguments. An important issue in building such representations is the intended and accurate attachment of newly raised arguments in the context of the previous debate. In this paper, we propose a method for determining likely attachment points for newly raised arguments, based on discourse concepts, such as given and new information in the natural language formulation of arguments. In the long run, the approach is likely to make the incremental building of formal representations easier and it may even lead to an increase of the accuracy of the formal representation in some cases.

1 INTRODUCTION

Building semi-formal and formal graphical representations of a natural debate can be supported by tools, such as ARAUCARIA [12] and its successors, dealt with in tutoring, e.g., for legal reasoning [1, 11] and for documenting the state of a public debate [17, 18]. One issue in using tools is the incremental update of some intermediate state of an argument graph by a new argument. In most cases, the user of such a system is expected to pick the appropriate attachment point for inserting the new argument, possibly supported by graphical navigation and inspection facilities, but hardly by content- and text-related concepts. This task may be associated with considerable burden on the side of the user, partially because of the size of a considerably grown argument graph, but also because a suitable position may not always be conceptually clear. Consequently, support in seeking likely attachment points for the new argument may be quite welcome, also in view of possible constraints on the new argument and its relations to previously raised ones (see [8, 9]).

In this paper, we propose a method for determining plausible attachment points for newly raised arguments, based on discourse concepts, such as given and new information in the natural language (NL) formulation of arguments, but also interpreting some typical argumentative roles expressed in NL. The content of such arguments is partially interpreted and maintained in context which yields evidence for the relations among the arguments as well as for their argumentative role - such as indicating whether they can be a support or an attack. We consider this approach a first step towards building a semantic representation of NL arguments, focused on their argumentative role, which aims at more rigour in the representation of arguments so that in the long run more formal reasoning services are enabled.

This paper is organized as follows. We first motivate the need for supporting the incremental update of formal representations of a natural debate. Then we outline a method that aims at finding plausible attachment points for a new argument in an argument graph that represents the current state of a debate. We illustrate this idea by a walk-through of a moderately complex example. Finally, we discuss the state of affairs and future prospects.

2 METHODOLOGY

In argumentation frameworks, the proper content of an argument which may have been made originally in NL is not accessible because its content is abstracted away in some atomic proposition p, or even in an argument identifier. Hence, given a new argument p in a debate, the task is to refer it to the appropriate p_i in the given state of an argument graph, according to the intention of the person who raised the argument ($p \rightarrow p_i$ for a support or $p \rightarrow \neg p_i$ for an attack). This may be associated with some cognitive load, in particular for argument graphs of increasing size. However, because the content of the arguments is completely abstracted away, there is no formal support possible from the side of a system.

However, if arguments are available in NL form, these formulations typically contain a number of linguistic clues, even without world knowledge, on the basis of which relations between arguments appear plausible. This is because arguments, though expressed in a concise and abbreviated form [2, 13] in comparison to [14] are not raised in isolation, but in an ongoing debate, where the person who raised the argument normally intends the audience to understand the underlying structure. In order to support this understanding, contributions in an argumentative debate are made in a coherent way as in any other NL text or conversation, by making use of cohesive measures. They include references, but also discourse markers, [7] distinguishes between additive, adversative, causal, and temporal forms.

When a new argument is raised, this is typically done in a form where *old* (*given*) and *new* information is combined in the NL formulation. Several linguistic theories (e.g., [10]) orient a certain perspective on coherence, prominently the focus of attention, on the role of given and new information, to support reference resolution and the maintenance of discourse objects in a discourse history representation, as first empirically analyzed in [6]. Similarly, the *new* information in an argument provides its proper contribution to the debate, while the *old* information is intended to provide evidence about where the new argument is

Function	*Description*
	Discourse functions
Given	Part of an argument covered by a previous one
New	New part, the complement of *Given*
	Access function to components of an argument
MainC	The *main claim* of an argument, without restrictions
MainE	The *main entity* of an argument
SubE	A *sub*ordinate *entity* of an argument
MainA	The *main assertion* of an argument, without main *entity*
Author	The witness or expert who made the argument
Content	The *content* of the argument made by someone else
	Assessment functions
Evalu+/-	The argument expresses a good or bad assessment
Change↑↓	The argument expresses positive or negative change
	Linguistic "bridging functions"
Para	One argument (portion) is a *paraphrase* of another one
Infer	One argument (portion) is *inferable* from another one

Table 1. The functions to access and link substructures of arguments

related to in the present debate. We understand an argument as a statement made by a participant in a debate, which may have the usual form of a support or an attack, but may also expand on the description of an argument already made; it may elaborate the content details of another argument, or add an explicit assessment. As shown in [9], such statements are better combined with the arguments they relate to rather than forming new arguments.

Some arguments may have a special form which expresses polarity, such as evaluatives "<x> is good/bad", and assertions about changes "<y> is in- or decreasing". Asserting evaluatives, also in combination with assertions about changes, is consistent with only one role of an argument. For example, if <x> is claimed to be positive or desirable, and <x> is claimed to be true or increasing, then an argument "<y> leads to or causes <x>" can only function as a support for <x>, but never as an attack on it. While these pieces of information can readily be applied to suggesting or restricting updates to the underlying argument graph, actually obtaining this information is rarely easy. Reference to given information may be indirect, implicit or encapsulated in some paraphrase, so that formally recognizing relations may be difficult in some cases. Moreover, work on discourse parsers, such as [5] are of limited help here, since they expect a well-structured prose text in their analysis and not an incrementally developing partial debate with many focus shifts; however, discourse parsers may help in interpreting rhetorical relations between adjacent propositions.

In order to support the recognition of cases as described above, we define substructures of NL arguments in an abstract form, to be used by an interpretation procedure. In Table 1, the functions needed to access components of arguments, to check

```
Procedure Propose-Attachment-Points (ArgTree,NewArg)
Attachments ← empty
forall Arg ∈ ArgTree do
   if Author (NewArg)
      then Common ← Compare (Arg,Content(NewArg))
      else Common ← Compare (Arg,NewArg) endif
   if Common
      then <Add the pair (Arg,Common) to Attachments> endif
endfor
return <sort Attachments according to size of Common parts>
```

```
Procedure Compare(Arg1, Arg2)
Argcommon ← empty
if Para(New(Arg1), Arg2) then return Arg2 endif
forall ArgPart ∈ {MainC(New(Arg1)),MainE(MainC(New(Arg1))),
      MainA(MainC(New(Arg1))), SubE(MainC(New(Arg1)))} do
   If Para(ArgPart,MainC(Arg2))
      then <add MainC(Arg2) to Argcommon> endif
   If Para(ArgPart,MainE(MainC(Arg2)))
      then <add MainE(MainC(Arg2)) to Argcommon> endif
   If Para(ArgPart,MainA(MainC(Arg2)))
      then <add MainA(MainC(Arg2)) to Argcommon> endif
   If Para(ArgPart,SubE(MainC(Arg2)))
      then <add SubE(MainC(Arg2)) to Argcommon> endif
return Argcommon endfor
```

```
Procedure Update (Attachment,Reference,NewArg)
<Add NewArg to Argtree>
Given(NewArg) ← <Reference in Newarg>
New(NewArg) ← <Complement to Reference in NewArg>
If New(NewArg) <is only an assessment>
   then <Propose-for-Conflation(Attachment,NewArg)> endif
```

Figure 1. The procedure for proposing attachment points for arguments

their substructure and to link them to components of other arguments are listed. An argument is conceived as a proposition, typically a state or an event, with entities involved, possibly with restrictions; it may be within the scope of a mental attitude, such as an expert opinion. Propositions are built with semantic case role fillers, abstracting away, for instance, from passive voice and function verb constructs. To start with, there are two complementing discourse functions, *Given* and *New*. The distinction between *Given* and *New* information supports the identification of potential links between arguments, including evidence for where some piece of information has first been introduced. Both *Given* and *New* are structured propositions corresponding to the entire argument, with annotations indicating the active parts, in a complementary way. In *Given*, the portions of an argument whose content is covered by some previous argument are marked, that is, this part serves as a reference to express linking between arguments. *New* is then what is not covered by

Given. Then some functions are defined which provide access to an argument's substructure that are potential candidates for identifying relations between arguments via their components. Components of an argument include its main claim (*MainC*), disregarding restrictions which may be expressed in subordinate clauses. *MainC* can be decomposed into its main entity (*MainE*), typically an agent, and the assertion ascribed to it (*MainA*), that is (*MainC* without *MainE*) and other subordinate entities (*SubE*). If an argument is embedded in a propositional attitude, that is, there is one external person referred to to which the argument content is attributed, the functions *Author* and *Content* are used to pull out the reference to that person and to the embedded argument. Moreover, arguments may take the specific form of "<x> is positive/negative" or "<y> increases/decreases". This may have consequences on the role of arguments related to such arguments. Functions *Evalu+*, *Evalu-*, *Change*$\uparrow$ and *Change*$\downarrow$ check for these forms. Finally, there are two functions which are intended to bridge variations in wording and reference to some piece of information: *Para* is a two-place function which yields true if two assertions or entities used as parameters are paraphrases of one another, that is, they are semantically equivalent; this may be verified, for instance, by systems checking for logical entailment, such as [3], in both directions, or by paraphrase checking systems. *Infer* is intended to cover more general cases, but since concrete criteria which inferences are adequate to be embedded in discourse references is a widely open question, we do not investigate this case here further,

The procedure searching for proposed attachment points is given in pseudo-code in Figure 1. It consists of the main procedure *Propose-Attachment-Points*, with a subprocedure *Compare*. This yields an ordered list of hypotheses, from which the person who produced the argument can choose. Once an attachment point is confirmed, the book keeping procedure *Update* is called. As an initialization, the point of debate, which constitutes the argument tree at the beginning, is completely marked as *New*. Then the procedure *Propose-Attachment-Ponits* is invoked for each newly raised argument *NewArg*. *NewArg* is compared with the genuine part (New) of all previously raised arguments in ArgTree, including the point of debate. The restriction to the New part of previous arguments to be compared is motivated by the preference to arguments where content has been introduced (is New) over those where it merely refers to (Given). A distinction is made as to whether the NewArg expressed a propositional attitude (Author) or not, to select the proper content for the comparison. The procedure Compare carries out the comparison, for the whole argument and for its components *MainC*, *MainE*, *MainA*, and its *SubEs*, checking whether any of these parts are semantically equivalent in some combination. Successful comparisons are collected and at the end sorted by the degree of commonality. There may be one, several or no candidates. Once the intended attachment point is picked by the person who raised the argument (which may be one of the attachment points proposed or another one), the procedure Update inserts *NewArg* in the argument tree and assigns its components the states of *Given* or *New*. In addition, Update proposes the conflation of two arguments if the new argument expresses only an assessment. No attempt is made yet to check consistency of argumentative roles.

1. Every householder should pay tax for the garbage which the householder throws away.
2. No householder should pay tax for the garbage which the householder throws away.
3. Paying tax for garbage increases recycling.
4. Recycling more is good.
5. Paying tax for garbage is unfair.
6. Every householder should be charged equally.
7. Every householder who takes benefits does not recycle.
8. Every householder who does not take benefits pays for every householder who does take benefits.
9. Professor Resicke says that recycling reduces the need for new garbage dumps.
10. A reduction of the need for new garbage dumps is good.
11. Professor Resicke is not objective.
12. Professor Resicke owns a recycling company.
13. A person who owns a recycling company earns money from recycling.
14. Supermarkets create garbage.
15. Supermarkets should pay tax.
16. Supermarkets pass the taxes for the garbage to the consumer.

Figure 2. The sequence of arguments in Wyner's running example

3 A RUNNING EXAMPLE

In this section, we introduce the running example used by Wyner and his co-authors [17, 18] to show how state-of-the-art natural language processing methods can be applied to build abstracted representations to be used by argumentation frameworks [4] under some simplifications – the restriction to controled English, and user cooperation to specify the role and scope of newly introduced arguments, from the perspective of how adequately the assertions to be ultimately incorporated into an argumentation framework are categorized and attached to the incrementally constructed argument graph (see Figure 2 for the list of assertions, and Figure 3 for the argument graph built out of them). In the argument graph, node labels refer to argument numbers in Figure 2, full arrows represent support links, dashed arrows represent attack links.

When a user raises a new argument, he also specifies the argument to which the new one is related and the category of that relation. Since humans generally tend to be sloppy in their formulations, express pieces of information in limited degrees of explicitness, especially in inference-rich discourse, and may find it hard to precisely identify semantic relations in a given context, we can expect a number of problems associated with user specifications of this kind.

Later, a transformation method has been proposed [8, 9] which leads to a variation of this argument graph (see Figure 4), that attempts to avoid ontological discrepancies and duplications, to uncover implicit information and to choose relations between assertions that are as conceptually accurate as possible. In two cases, two nodes are combined into a single one (3 and 4, as well as 5 and 6), In addition, some changes in the arguments

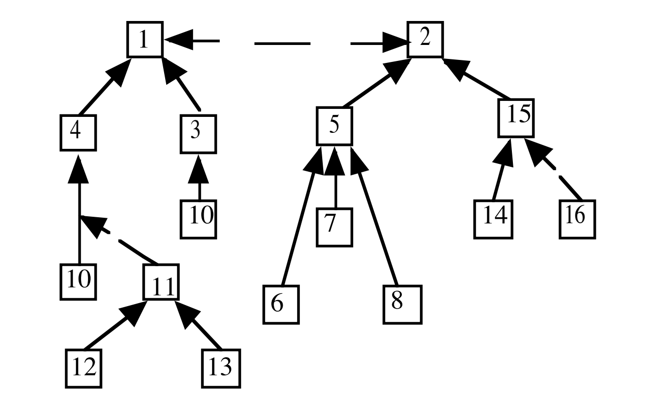

Figure 3: The original argument graph by Wyner [17, 18]

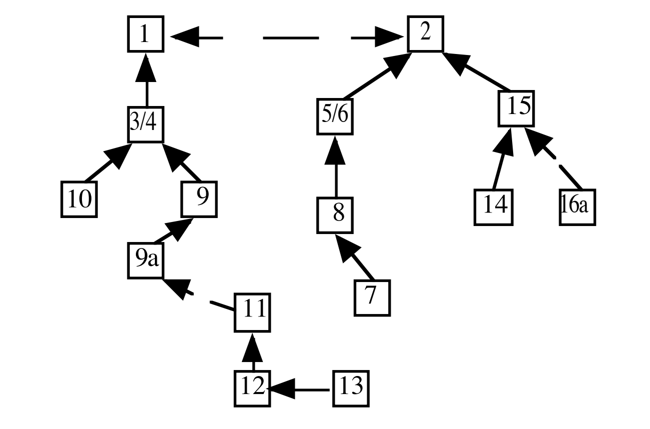

Figure 4: The revised argument graph according to [8, 9]

are made, thereby introducing new arguments, such as 9a, which represents the argumentation scheme relying on expert opinion and changing arguments, such as 16a, which can be paraphrased by "customers pay for the garbage" (a logical consequence of argument 16), Finally, the structure of the graph may be changed in some parts, to obtain semantically more accurate relations, such as direct rather than indirect attacks. In the following, we refer to each version of the argument graph and discuss relations, discrepancies and support for obtaining ontologically more accurate representations where appropriate

4 WALKING THROUGH THE EXAMPLE

In this section, we illustrate the envisioned effects of our method, exemplified by Wyner's running example. We sketch the incremental building of a new argument graph, geared by the proposals for attachment points at every newly raised argument. The first two assertions, the points of the debate, we treat as a union since one is the negation of the other. The subsequently raised arguments are dealt with as follows:

3. *Paying tax for garbage increases recycling.*
   In this argument, its main entity (*Paying tax for garbage*) is considered a paraphrase of the claim's main assertion (*Should pay tax for the garbage,* disregarding modality). *Increases recycling* then becomes the *New* part of this argument.
4. *Recycling more is good.*
   The main entity of this argument (*Recycling more*) is assessed as a paraphrase of the *New* part of the previous argument (increases *recycling*), the only match. Since the argument conforms to the *Evalu+* pattern, its embedding in the previous argument is proposed to yield a support of the positive variant of the point of dabate. This conflation of arguments corresponds to the version of the argument graph in Figure 4.
5. *Paying tax for garbage is unfair.*
   The main entity of this argument (*Paying tax for garbage*) is a paraphrase of the main assertion of the point of debate, yielding *is unfair* as the *New* part. Note that a reference to argument (3) is not validated, since *Paying tax for garbage* is marked as *Given* in this argument.
6. *Every householder should be charged equally.*
   The best match for this argument is between its main entity and the main entity of the point of debate. The contrast between *unfair* and *should be charged equally* as a reason for a link would require too much inference capabilities.
7. *Every householder who takes benefits does not recycle.*
   For this argument, there are two possible attachments: (1) *Every householder* with the main entity of the debate, and (2) the main assertion *does not recycle* with the *New* part of argument (3), as a weakly related paraphrase, at least. Recognizing some sense of the apparently intended rule, "it is unfair, because some householders do not recycle" is out of reach.
8. *Every householder who does not take benefits pays for every householder who does take benefits.*
   This argument has a stronger relation to the previous one (7) via *Every householder who does (not) take benefits* than to the main point of debate, which is merely via *Every householder*. Hence, a supporting relation between arguments (7) and (8) is suggested as in Figure 4 rather than these arguments being sister nodes as in Figure 3.
9. *Professor Resicke says that recycling reduces the need for new garbage dumps.*
   In the content of this embedded argument, the main entity, *recycling*, gives rise to two potential attachment points - the main entity of argument (3) and, to a less direct extent, *does not recycle* in argument (7).
10. *A reduction of the need for new garbage dumps is good.*
    In relation to the previous argument, this argument is structurally almost identical to argument (4) in connection with argument (3): it matches the *New* part of argument (9), only adding an evaluation. Similarly as with the previous pair of arguments, their conflation in the representation is proposed, which is even more compact than the version in Figure 4.
11. *Professor Resicke is not objective.*
    Through reference to a previously introduced person, the proposed attachment point prominenty stands out here.

12. *Professor Resicke owns a recycling company.*
The main entity in this argument, *Professor Resicke* can refer to its previous references in arguments (9) and (11); the stronger connection between *is not objective* and *owns a recycling company* is not recognizible.
13. *A person who owns a recycling company earns money from recycling.*
For this argument, the main entity matches the *New* part of the previous argument. It is therefore proposed to expand on it (Figure 4), rather than to become its sister node (Figure 3)
14. *Supermarkets create garbage.*
For this assertion, only the embedded entity *garbage* matches with components of other arguments; but only in its role of an embedded concept of the point of debate, this is considered successful. In argument (3), garbage belongs to the *Given* part so that this argument is not a suitable attachment point.
15. *Supermarkets should pay tax.*
This argument can be attached to the previous one since they share the main entity, *Supermarkets*. In addition, the point of debate also qualifies as an attachment point, because it shares the main assertion *should pay tax* with the new argument. The preference among these two, including the relation between arguments (14) and (15) is hard to assess. None of the approaches addressing the running example proposed criteria for adjoining argument (15) in between argument (14) and the point of debate, as the human did.
16. *Supermarkets pass the taxes for the garbage to the consumer.*
This argument has a stronger relation to the previous argument via its main entity *Supermarkets*, than to the point of debate by its embedded entity *the taxes for the garbage*. Since argument (15) is previously established in a place so that argument (14) depends on it, *Supermarkets* is only accessible for reference in argument (15), where it is *New*.

6 CONCLUSION AND DISCUSSION

In this paper, we have described a method that aims at identifying and proposing attachment points for newly raised NL arguments in a given state of an argument graph. The method makes use of some linguistic concepts to select components in the NL formulation of arguments and to interpret their argumentative role, prominently *Given* and *New* information. As it has been demonstrated by a small example, the choices made are mostly reasonable, but not always as (possibly) intended by the human. In addition, some relations between arguments have been found to be superior to those chosen by the human in some cases. We believe that our method is not only useful to support navigation for the incremental building of argument graphs; it can also support the categorization and placement of newly raised arguments, and, in the long run, enable logical reasoning services.

Admittedly, the degree of elaboration is still on some kind of anecdotal level so far. The interpretation of some of the predicates used in the formalization need to be fleshed out more precisely. In particular, this comprises the *Para* predicate, that determines whether two assertions are paraphrases of one another or somehow close to it to justify an argumentative reference. In addition, precisely elaborating the access functions to components of an argument, such as main entity, are to be done. The success of the method will largely depend on how the predicates *Para* in *Infer* can be fleshed out so that a reasonable share of references can be established with acceptable effort.

In the future, we intend to address these issues of formalization, as well as to investigate the application to larger corpora of argumentative texts. A useful extension of the method is a more fine-grained elaboration of preferences on attachment points, geared by the focus of attention, similar to models of ordinary discourse. Moreover, distinctions among modalities may yield evidence for preferred structures among arguments. Finally, knowledge about argumentation structures [15, 16], such as argumentation schemes may be exploited.

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