Toulmin Diagrams in Theory & Practice: Theory Neutrality in Argument Representation

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ABSTRACT
The Toulmin diagram layout is very familiar and widely used, particularly in the teaching of critical thinking skills. The conventional box-and-arrow diagram is equally familiar and widespread. Translation between the two throws up a number of interesting challenges. Some of these challenges (such as the relationship between Toulmin warrants and their counterparts in traditional diagrams) represent slightly different ways of looking at old and deep theoretical questions. Others (such as how to allow Toulmin diagrams to be recursive) are diagrammatic versions of questions that have already been addressed in artificial intelligence models of argument. But there are further questions (such as the relationships between refutations, rebuttals and undercutters, and the roles of multiple warrants) that are posed as a specific result of examining the diagram inter-translation problem. These three classes of problems are discussed. To the first class are addressed solutions based on engineering pragmatism; to the second class, are addressed solutions drawn from the appropriate literature; and to the third class, fuller exploration is offered justifying the approaches taken in developing solutions that offer both pragmatic utility and theoretical interest. Finally, these solutions are explored briefly in the context of the *Araucaria* system, showing the ways in which analysts can tackle arguments either using one diagrammatic style or another, or even a combination of the two.

KEYWORDS
Argument analysis; Argument diagramming; Argument software; Computational Models of Argument; Toulmin diagrams

INTRODUCTION

The analysis of arguments is often hard, not only for students, but for experts too. As a result, a variety of tools and techniques have emerged from the theory of argumentation and the theory of argument/informal logic/critical thinking pedagogy that aim to help in the task of analysis. One of the most common and intuitive of these tools is diagramming, by which the abstract form of an argument can be identified and seen at a glance, and according to which it is then possible to analyse more closely the relationships between an argument's parts. The utility of argument diagramming is seen in its almost universal adoption in the teaching of critical thinking and argumentation skills, as well as its deployment in various practical tools employed where complex argumentation is part of a profession (most notably in legal domains). There are a wide range of diagramming techniques, some very general, some tailored to particular domains. But there are two that are perhaps most well known through the various pedagogic and professional applications of argumentation theory.

The first technique is the conventional “box-and-arrow” approach of identifying atomic components of an argument, and then indicating links between them with arrows. One of the first proponents of the approach in a pedagogic context was Beardsley (1950), and little has changed since then. In addition to identifying relationships of support between atoms in an argument, the scheme has become refined to also identify four distinct ways in which compounds can be formed: as serial argument (in which one statement supports another, which in turn supports a third); convergent argument (in which two or more statements independently support a third); linked argument (in which two or more statements jointly support a third) and divergent argument (in which two or more statements are supported by a third). Complex argumentation can be constructed through arbitrarily complex combinations of these forms. As it is so familiar to many, and by analogy to the terminology used in fallacy theory, we here refer to this “box-and-arrow” approach as the *standard treatment* of diagrammatic argument analysis.

But almost contemporaneously with the development of the standard treatment, a second approach, which sprang from quite different concerns, has developed into an equally successful, well known and widely used method for diagramming, *viz*. the Toulmin schema (Toulmin, 1958). Rather than viewing arguments as essentially just more or less complex binary relationships of support, Toulmin sees arguments as six-part complexes, comprising the familiar Data, Warrant, Claim, Backing, Rebuttal, Qualifier. Though the starting point was jurisprudential, the resulting theory and its subsequent application are very general, and a Toulmin-style approach, replete with appropriate diagrams is commonplace in current undergraduate curricula.

An important observation is that both the standard treatment and the Toulmin schema are, of course, much more than just ways of drawing pictures. There is more to the standard treatment than p2 of (Freeman, 1991), in just the same way that there is more to Toulmin than p104 of (Toulmin, 1958). Both systems embody many theoretical assumptions and conclusions, and work as a way of packaging up substantial theories into practical tools that are simple and easy to understand – and produce analyses that are the products of those background theories. The motivation that drives the remainder of this paper is a challenge initiated through the apparently harmless desire to allow diagrams in one form to be translated into another. The challenge lies in the fact that for a variety of reasons, such translation demands coherence and interaction between the two approaches at a deep, theoretical level. For if an analysis embodies the theory by which it has been constructed, then transmutation of that analysis into one constructed in according to a different theory demands some sort of tying together of the two theories.

Working specifically in the context of the diagramming tool *Araucaria* (Reed & Rowe, 2004), the aim here is to develop both the theory and implementation (in software) of diagramming tools that are “theory neutral”. Specifically, therefore, there are several objectives: (i) It should be possible for diagrams to be constructed in more than one theoretical framework; (ii) Resulting analyses should be stored in a common format; (iii) Partly as a result of (ii), it must be possible to convert, in software, from a diagram in one theoretical framework to an equivalent in another; (iv) Conversion according to (iii) must be consistent and deterministic, and should not require additional input from the user; and (v) Analysts working solely within one theoretical framework should not be impacted at all by features, contrivances or oddities from other theoretical frameworks. These concrete objectives for software development frame a research project that tackles both theoretical and practical strands of work.

TRANSLATION

The first building block concerns the simplest structural translation: from a Data-Warrant-Claim (henceforth, DWC) complex of a Toulmin analysis, to a linked argument in the standard treatment. Linkage expresses some need for both components to be present (explicitly or implicitly) in order for the argument to go through. Sometimes, moving from one linked premise to another functions as a way of delivering or manifesting relevance between premise and conclusion. Freeman (1991) offers a dialectical analysis, such that a linked premise is elicited by asking, "Why is that [first premise] relevant [to that conclusion]?" Freeman's discussion is tabled in the context of the Toulmin warrant, and although he identifies many problems with explications of the latter, we are not here trying to critique either of theories involved. Instead, the aim is to adopt them "warts and all", and provide mechanisms for those that adhere to one or the other (or both) to work within their frameworks. There seems, in this context, to be good reason therefore for identifying the DWC complex with a linked argument in which a single conclusion is supported by two linked premise. In combination with the direct mapping of argument atoms, Figure 1 below is therefore a reasonable intertranslation[1]:

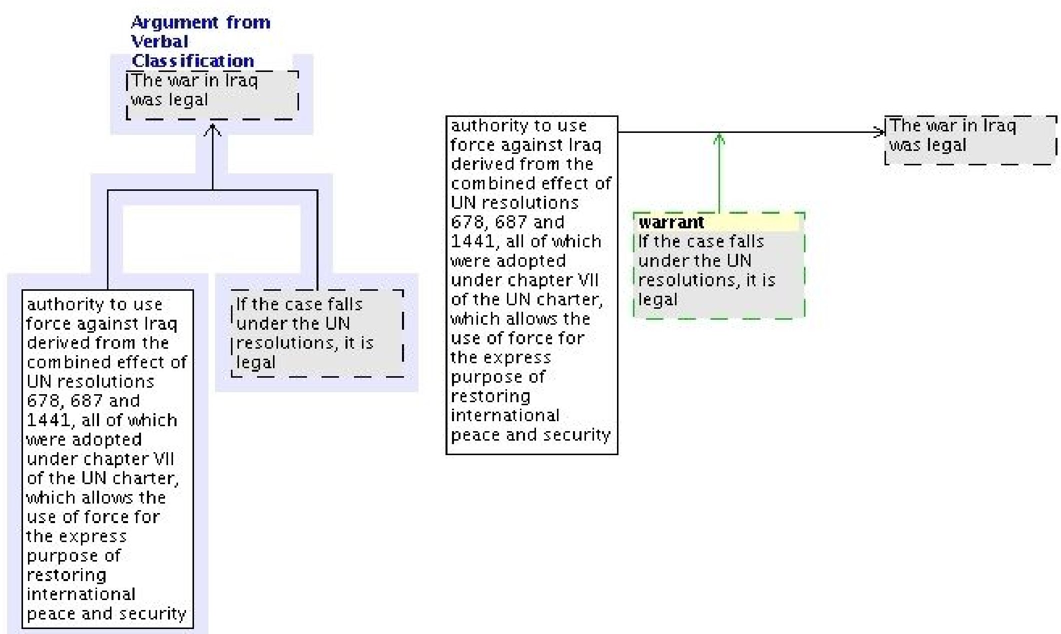

Figure 1. A linked argument as a single DWC complex

(The example is taken from Hansard, and is taken from the *AraucariaDB* online corpus). It is

1 All the figures in this paper have been produced using *Araucaria* which is available for download from `http://araucaria.computing.dundee.ac.uk`

important not to read too much in to Figure 1. Specifically, it is not making ontological claims about the interpretation of one language for expressing argument *by* another (though it is providing interpretation of one language *in* another). For some authors, presumably including Toulmin, the warrant is most certainly not a premise (Hitchcock, 2003): the Toulminian framework is simply and deeply richer than that. Yet in the standard treatment, there are no other ontological categories. With a Toulminian analysis of some argument that yields a DWC complex, how might a standard treatment analyst go about performing the same analysis? Without a concept of warrant, it seems reasonable that that analyst might view two components of the argument as linked premises – and one of those would happen to correspond to what the Toulminian identified as a warrant. In this way, there is no implicit claim that either analysis is right, or more right, or more basic, but merely that the analysis conducted in one framework might be rendered in such a way as to make sense to an analyst from another framework. This is what Figure 1 is depicting.

In the standard treatment, a linked argument can have any number of premises; a Toulmin analysis on the other hand typically has a single datum and a single associated warrant. How then, can many-premised linked arguments be faithfully represented in Toulmin schema? One possibility is simply to ignore linked premises beyond the first two – i.e. a Toulmin analysis recognises exactly one D, W and C in each DWC complex. This is unattractive because it fails to preserve information between frameworks. Perhaps, then, an additional premise in a linked argument might be seen as a fulfilling one of the other roles in the Toulmin model. Unfortunately, there are no other roles that could be filled in a consistent way: the relationship between backing and warrant is most closely similar to the relationship of support in the standard treatment – and not the relationship holding between "sibling" premises. The only alternative left open is to broaden what Toulmin diagrams can handle, either by allowing more than one datum in an argument, or allowing more than one warrant. Permitting more than one datum in a single DWC complex is counter intuitive (multiple data as bases for multiple DWC complexes all supporting the same claim is a different problem, tackled below). A single datum seems to offer a single basis from which to build an argument to support a claim. The final option – to permit multiple warrants – is a little strange, but not downright offensive to the Toulminian theoretical framework, particularly given more recent exegesis: 'The question [for a warrant] is not "How do you get there?" but "How might you get there?" And then: "Is one of the ways you might get there a reliable route?" ' (Hitchcock, 2003: §4) So, perhaps the best (default) Toulminian interpretation of a standard treatment analysis involving more than two linked premises is of an argument with more than one warrant. Though taking liberties with the Toulmin picture, this meets objectives (iii) and (iv) from the introduction, and most importantly, means that as described in objective (v), analysts working in either tradition needn't worry about the foibles of the other (just because Toulmin diagrams can be constructed in which more than one warrant supports the move from datum to claim does not mean that such analyses will be at all common for those working in the Toulmin framework).

A similar approach is required with another general problem. The standard treatment allows the construction of analyses of arbitrary complexity and depth. In this respect it is like most methods for analysing, synthesising and representing argument, including Wigmore's

(1931) method of analysing legal argument, Pollock's (1995) argumentation based reasoning system, and so on. Toulmin was unconcerned with such larger scale structures, and focused therefore upon the simple, individual argument with its six components. The simplest solution to this problem is to see each of the components as points for expansion. That is, if a given argument, A, for some claim comprises a datum, a warrant, a backing, a rebuttal and a qualifier, then each of those five components might stand as a claim in some other argument, B. In this way, Toulmin arguments can be glued together. From a computational point of view, this is extremely attractive, as it allows a simple recursive definition that supports Toulmin diagrams of arbitrary complexity.

The penultimate translation issue is interesting in that a number of computational interpretations of Toulmin omit the category entirely. Backings are perhaps the clearest indication of the jurisprudential background to the Toulmin model, indicating links to legal precedents, case law and so on. Though these are adapted in some work (so, for example, Fox*et al*. (1996), use backings to indicate links into the medical literature in their Toulmin model of oncological reasoning), the challenge is often that the relationship between backing and warrant is identical, ontologically and formally, to the relationship between a warrant in one DWC complex that is standing as a claim in another, and the datum in that other complex. Referring to Figure 2, if we permit the recursivity conditions that allow arguments of arbitrary complexity, as discussed above, then we must permit diagrams such as the one on the left. But in that case, it is difficult to see how it differs in any important way from the analysis on the right.

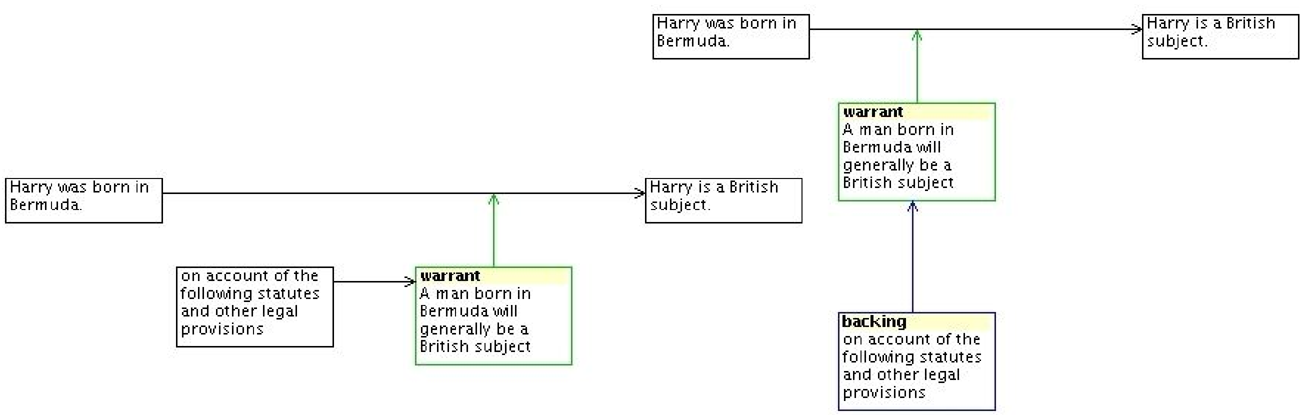

Figure 2. Two ways of supporting a warrant.

The argument from a Toulmin perspective would undoubtedly turn upon the nature of the material that constitues the “on account of” component in Figure 2. And that determination may be context-dependent: in some circumstances one may want to ask of the leap from backing to warrant, “How did you get there?” - and if so, perhaps the lefthand approach is analytically clearer. Alternatively, if one is focusing upon the data-claim link, and the backing is merely an anchor in the literature of the field, then the relationship between the backing and the warrant may be self-evident and the right hand analysis be more appropriate. Similarly, if the literature (case law, medical scholarship, etc.) is itself inconsistent and contestable, then perhaps there will be call for analysis between those components – in that case, the recursive structure of either the left hand picture, or even the more complex structure of Figure 3, is more appropriate.

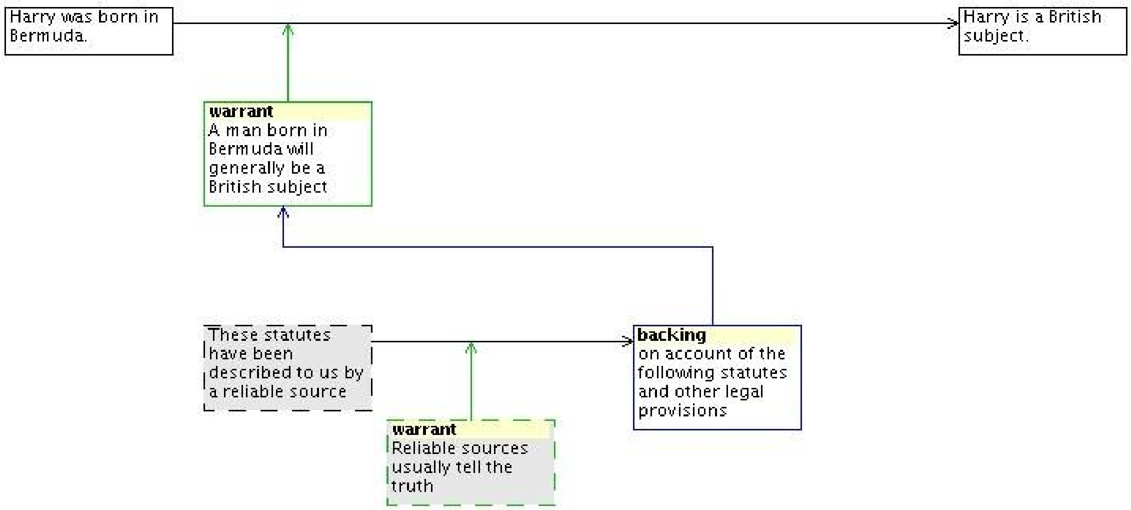

Figure 3. Supporting a backing.

The conclusion is that there are good reasons why an analyst might use any one of these structures in a given case, so it is neither the job of theoretical structure nor software tools to proscribe any of them. Each is permissible in *Araucaria*. The default is the conventional DWBC structure, but changing to either alternative is a simple matter. The problem lies in the translation. The decision as to which of the two diagrams in Figure 2 (or alternatively the one in Figure 3) should apply in a given situation is a decision that only has meaning within the Toulmin framework. Without the ontological difference (and rather slippery ontological difference at that) between backing and data-supporting-a-warrant, the standard treatment cannot distinguish (and indeed, should not distinguish) between the two approaches. As a result, the two analyses in Figure 2 should be rendered identically under the standard treatment: this is the approach adopted in *Araucaria*. In order to meet the objectives listed in the introduction however, it is important that (a) any analytical decision taken under the Toulmin view is implicitly preserved even under the standard treatment, and (b) there is a deterministic way of identifying an appropriate Toulmin interpretation of the Toulmin-ambiguous standard treatment analysis. The solution to (a) lies in a general approach which is also employed in the data/warrant distinction, where there is an analogous problem of under-specification in one theoretical framework with respect to the distinctions that can be made in another. Each theoretical framework has various roles that it identifies for the atoms of argument. Those roles can be characterised by restrictions upon how they interact. A Toulmin backing, for example, cannot stand to support a qualifier. The identification of which components stand in which roles can only be carried out within the appropriate theoretical framework: identifying a component as a backing can only be carried out in the context of a theory, such as Toulmin's, that has backings. These role-assignments, by their very nature, cannot easily be represented in some lowest common denominator of an argument theory: any technique for translation must simply respect the differences in the target theories. But on the other hand, the mechanisms for translation must nevertheless be principled and well defined to avoid a combinatorial explosion in the effort of translating either large arguments, or arguments between large numbers of theoretical frameworks. The approach taken in *Araucaria* is to allow theory-specific roles to be identified, represented, and stored explicitly in the underlying language. So, in that language, a single component of an argument may simultaneously instantiate a backing role in the Toulmin theory, and a premise role in the standard treatment theory. Equally, if the analyst has not specified a role for a component in a given theory, then that role is simply undefined - or, more accurately is defined implicitly and by default through the semantics implemented in software. This is the solution to (b), in that a default translation is applied. Here, that default is to interpret support for warrants as a new DWC complex rather than as a backing – though in this case and in general, such defaults can be overriden by the analyst.

The final component of the Toulmin picture is perhaps the single most troublesome – and most interesting from a theoretical point of view: rebuttals. Most standard treatment systems involve some mechanisms for identifying conflicts: propositional negations, counter-positions, incompatibilites, etc. For some reason, there does not seem to have emerged a consensus on how best to deal with the issue diagrammatically. This has transferred directly into software implementations of diagramming methods: Reason!Able, for example uses coloured arrows (van Gelder, 2003), Argue! has lines terminated in diamonds (Verheij, 2003) and so on. *Araucaria*'s solution is to use double-headed horizontal lines, and to restrict any given proposition to a single conflicting proposition (though that proposition in turn may have an additional conflicting proposition that is not the first, and so on). Whatever the exact mechanism for handling and representing these conflicts, the challenge is the same: is it possible to construe Toulmin rebuttals in terms of standard treatment refutations?

There seem to be (at least) four possible standard treatment interpretations of the Toulminian notion of rebuttal, summarised in Figure 4.

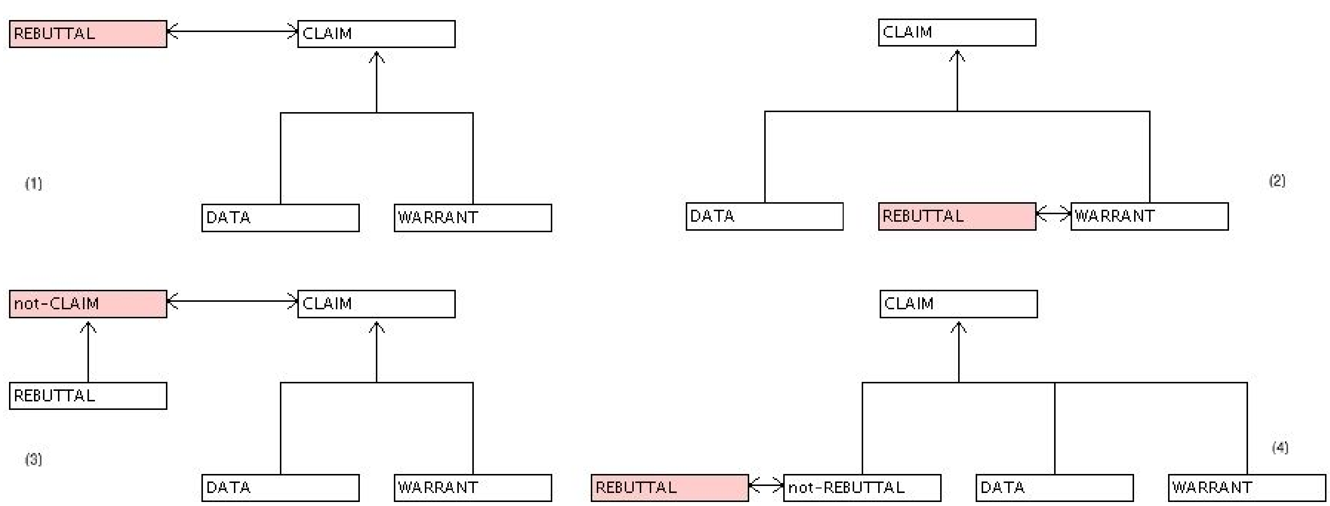

Figure 4. Four candidate standard treatment interpretations of Toulmin rebuttals

The first candidate is that a rebuttal refutes its claim (we use *rebuttal* to refer specifically to that Toulmin role, and *refutes* to refer specifically to the countering relationship expressed by a horizontal line in *Araucaria*'s implementation of the standard treatment). The single largest problem with this approach is that it seems to fail to capture accurately the function of the Toulmin rebuttal. Not only the examples in (Toulmin, 1958), but even the very diagrams that label rebuttals with "unless", suggest that rebuttals function not to refute the claim, but to capture exceptions, objections or ways in which the argument may not apply (and may perhaps not apply in the case at hand). In this way, rebuttals are functioning in a manner akin to undercutters in Pollock's (1995) terminology[2]. Undercutters take on the role of defeating an argument by attacking the inference, the way by which a conclusion was derived. Of course, in the Toulmin framework, the "way by which a conclusion was derived" is captured specifically by the warrant. Perhaps then, a second possible interpretation is more favourable: the rebuttal refutes the warrant. Again, though, this perverts the explication laid out by Toulmin. In the initial example, used in Figure 3, above, the warrant is "A man born in Bermuda will generally be a British subject". It is surely not the case that the rebuttal, "Both his [Harry's] parents were aliens" refutes this general statement. Even if the rebuttal is true in a specific circumstance, the general presumptive rule might nevertheless hold true. It might be argued that what the rebuttal does serve to do in this case is to lend implicit support to the conclusion that (in this case) Harry is not a British subject. This, then, offers a third possibility: that a rebuttal supports a refutation of the claim. The claim, C, has some counterposition which might be expressed loosely with the gloss, "it is not the case that C". This component itself is then supported directly by the rebuttal. Though this seems to work in the Harry case, it captures our intuitions poorly since the rebuttal is now interpreted as being entirely distinct from the data and warrant – under this interpretation a rebuttal is interacting only with the claim, and not with the way in which the claim is being derived. Furthermore, if the relationship between rebuttal and Pollock-style undercutter is close, then Pollock's analysis is in direct conflict with this third option, for, crucially, undercutters do not offer support for any counter to the conclusion. Pollock offers the example shown in Fig. 5:

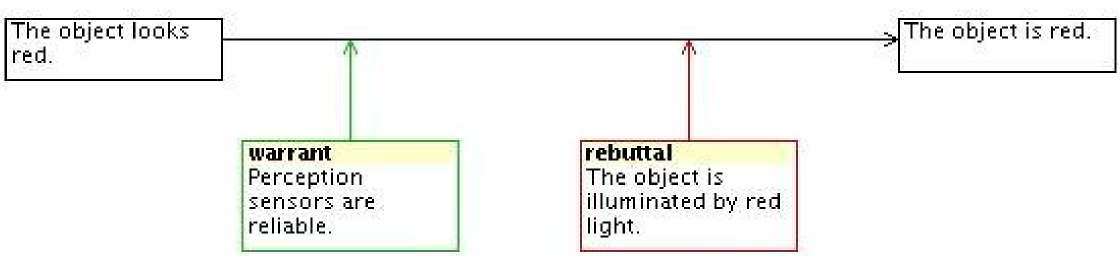

Figure 5. Pollock-style undercutters as Toulmin rebutters

Here, the fact that an object is illuminated by red light offers no support whatsoever for concluding that the object is not red. But it certainly casts doubt on the inference that it looking red suggests that it is, in fact, red.

2 It is an unfortunate feature of terminology that Pollock contrasts these undercutters with direct counters that he calls rebutters. We re-emphasise that here we use the term rebuttal strictly in its Toulminian sense.

Is there, therefore, a way of capturing this undercutting style of attack that seems so close to the Toulminian notion that a rebuttal serves to identify objections or exceptions to the way in which the conclusion has been reached using the warrant? There are two ways of achieving such a representation that are structurally identical, but semantically quite different. The first is to reify the inference. In this way, the DWC complex implicitly includes another component – represented, perhaps, by the horizontal line. The inference then runs, roughly, given the datum and the warrant, it is reasonable to conclude the claim. It is this implicit premise, that the rebuttal refutes. The approach has a direct counterpart in more traditional models of inference. A conventional approach to first order logic uses the principle of Modus Ponens to get from premises A and $(A \rightarrow B)$ to conclusion B. But it is just as reasonable to extract the leap of faith or "inference rule" and identify it explicitly, as a premise: A, $(A \rightarrow B)$, $(A \wedge (A \rightarrow B)) \rightarrow B$. The Carrollian regress looms instantly, and threatens the Toulmin model in an identical way if we go down this path. In addition to being a sly way of "deductivising" any non-deductive theoretical framework, a further problem is that it is far from clear that having the rebuttal refute this implicit premise is any better than having it refute the warrant. It may well be that the datum and warrant do still plausibly support the claim, even if the rebuttal holds.

The final alternative then, is to introduce an implicit premise, but have that premise represent nothing more than the counter of the rebuttal. This implicit premise might be seen (by the analyst) as an additional warrant. It could be that it is an attack on the entire inference scheme. It could be a specialisation of the warrant that is expressed. But perhaps the most common and accessible interpretation will be that this missing premise is some kind of implicit assumption. In this way, it is very similar to the implicit components expressed in argumentation schemes (Walton, 1996; Katzav and Reed, 2004). The approach taken in *Araucaria* (partly because it is designed also to handle such theoretical structures) is to use this scheme-like approach in implementation (cf. Bex *et al*. 2003). This approach naturally handles "conditions of exception or rebuttal" (Toulmin, 1958: 101) and "circumstances in which the general authority of the warrant [should] be put aside" (*ibid*.) as well as the full range of interpretations of rebutting used by analysts based on Toulmin's brief and ambiguous presentation. It also means that there is a clear relationship between components of argumentation schemes in the standard treatment and their (automatic) characterisation in Toulmin diagrams.

There remains a problem. The function of a rebuttal in a Toulmin diagram is, on our understanding of it, one of challenging an inference. The function of standard treatment refutation, at least as implemented in *Araucaria*, is one of representing some sort of dissonance between statements. These two theoretical frameworks thus manifest a fundamental difference in the way they handle inference: essentially, the former has a metaphysical basis that identifies multiple forms of inferencing, whilst the latter is cast in the deductivist mould. The only straightforward way in which translation between them might be accomplished is to reify the inference types of the former, so that they can be represented explicitly as statements in the latter. The problem then, is that it might be argued that the richer model is weakened by its translation to the more formal model. The first observation to make in response to such a challenge is that it is interesting and perhaps surprising that an apparently simple diagramming translation problem is intimately tied to the great deductivist debate that is still going strong (witness, e.g. (Groarke, 1999) and its responses). We do not here seek any kind of resolution of that debate, but rather seek to build a pluralistic approach that allows analysts and researchers to work within their many theoretical frameworks, allows work conducted in one to be re-used in another, and, perhaps, allows research exploring the differences between frameworks to have practical support.

CONCLUSIONS

We have presented mechanisms for translation between the standard treatment of box-and-arrow diagrams and the Toulmin model of analysis. Such intertranslation makes possible a single piece of software that can support teaching, diagramming, storage and manipulation of argument structures in the two frameworks. But more than that, it offers a mechanism for interchange and reuse between communities. As an example, *Araucaria* has been used to develop a corpus of natural argument, comprising over 500 analysed extracts from a wide variety of sources in several languages from around the world. The work was carried out as part of a project investigating argumentation schemes, and as a result adopted the standard treatment for its primary method of analysis. That corpus is currently being employed in a variety of research work, but is also available for teaching. With mechanisms for translation, a rich resource is now available not only to educators who use the argumentation scheme techniques, but also those who use the Toulmin model in the classroom.

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