On the nature of argument schemes

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1 Introduction

Since the 1980s, computer science, especially artificial intelligence (AI) has developed formal models of many aspects of argumentation that since the work of Toulmin and Perelman were thought of as belonging to informal logic. Doug Walton is one of the argumentation theorists who has recognised the relevance of this body of work for argumentation theory. One of the concepts on which recent work in AI has shed more light is that of argument schemes (sometimes also called 'argumentation schemes'), which features prominently in Walton's work. A study of argument schemes from the perspective of AI is therefore very appropriate for this volume in honour of his work. More precisely, the aim of this paper is to use insights from AI to propose an understanding of the nature of argument schemes as a means to evaluate arguments, and to compare this understanding with Walton's own account of argument schemes.

Walton regards argument schemes as essentially dialogical devices, determining dialectical obligations and burdens of proof. Using this account, a procedure for evaluating arguments should take the form of a set of dialogue rules. I shall instead argue that argument schemes are essentially logical constructs, so that a procedure for evaluating arguments primarily takes the form of a logic. More specifically, I shall argue that most argument schemes are defeasible inference rules and that their critical questions are pointers to counterarguments, so that the logic governing the use of argument schemes should be a logic for nonmonotonic, or defeasible reasoning. The dialogical role of argument schemes can then be modelled by embedding such a logic in a system for dialogue, so that in the end argument evaluation with argument schemes is a combination of logical and dialogical aspects.

However, after having developed this account, I shall also argue that not all argument schemes naturally fit the format of defeasible inference rules and that there is an often overlooked distinction between two types of argument schemes. One type fits the model of defeasible inference rules, i.e., elements of a reasoning method, but another type can better be seen as a reasoning method in itself. To model reasoning with such argument schemes, an account is needed of how reasoning methods can be combined, and I shall argue that this goes beyond the usual nonmonotonic logics and dialogue systems.

2 Walton on the nature of argument schemes

A common description of argument schemes is that they are stereotypical non-deductive patterns of reasoning, consisting of a set of premises and a conclusion that is presumed to follow from the premises. Uses of argument schemes are evaluated in terms of a specific set of critical questions matching each scheme. More precisely, on a "standard account" (Godden and Walton; 2007), uttering an instance of an argument scheme in a dialogue creates a presumption in favour of its conclusion and a corresponding burden of proof for the other side in the dialogue to defeat this presumption by asking critical questions. Asking a critical question defeats the presumption and shifts the burden to answer the question to the proponent of the argument. If he gives a satisfactory answer to the question the presumption is reinstated and the burden shifts back to the opponent of the argument to ask another critical question, and so on.

Recently, Walton has refined this "standard account" of the effect of critical questions (Walton and Reed; 2003). Some critical questions ask whether a premise of the argument is true (and if this premise was not stated by the other side, such a question in fact identifies a hidden premise of the argument). Asking such a question creates as described above a burden on the other side to back the premise with further grounds. However, other critical questions point at possible exceptional circumstances which, if true, would defeat the use of the argument scheme. Asking such questions does not shift the burden back to the other side: instead, the one who asks such a question must back it up with some evidence as to why the exception would be true. Only if such evidence is provided, the burden of proof shifts back to the proponent of the original argument.

Let me illustrate this with the *argument scheme from the position to know*, as given by Walton (1996, pp. 61–3):

a is in the position to know whether A is true
a asserts that A is true

A is true

which has the following three critical questions:

(1) Is a in the position to know whether A is true?
(3) Is a an honest (trustworthy, reliable) source?
(2) Did a assert that A is true?

In Walton's standard account, asking any of these three questions puts a burden on the proponent of the argument to back the challenged premise with further grounds. However, in his refined account this only holds when the first or third question is asked: asking the second question instead puts a burden on the opponent of the argument to provide grounds why a would not be honest (trustworthy, reliable). Of course, sensible dialogue rules can permit the opponent to also combine the first and third question with grounds why the answer would be negative, but in Walton's account they should not require this.

As said above, on this account (in both the standard and more refined form), the role of argument schemes in evaluating arguments is essentially dialogical: an argument is a move in a dialogue and the scheme that it instantiates determines the allowed and required responses to that move by the other side. In other words, for an argument to be justified it is not sufficient for it to fit a recognised argument scheme: it should also survive a dialogical process of critical examination.

3 Logics for defeasible argumentation

For some thirty years now, logic-based AI has been concerned with the logical formalisation of 'nonmonotonic' or 'defeasible' reasoning. The first nonmonotonic logics were meant to formalise 'quick-and-dirty' reasoning with empirical 'default rules' (such as 'Italians are usually Catholic' or 'witnesses usually speak the truth'), where one applies a default rule if nothing is known about exceptions, but one is prepared to retract a conclusion if further knowledge tells us that there is an exception. Later the focus was broadened to other forms of defeasible reasoning, such as various forms of causal or temporal reasoning, induction and abduction. One might even say that AI has replaced the old philosophical distinction between deductive, inductive and abductive reasoning with a new distinction between deductive and defeasible reasoning, where induction and abduction are just some of the species of defeasible reasoning.

Technically, nonmonotonic logics have been defined in several forms. Originally, fixpoint, consistency-based and preferred-model approaches were very popular. Later argument-based approaches were introduced, according to which defeasible reasoning takes the form of constructing arguments, attacking these arguments with counterarguments, and adjudicating between conflicting arguments on grounds that are appropriate to the conflict at hand. For an overview see Prakken and Vreeswijk (2002).

Two kinds of such logics exist. Some, e.g. Bondarenko et al. (1997) and Besnard and Hunter (2008), locate the defeasibility of arguments in the uncertainty of their premises, so that arguments can only be attacked on their premises. Others, e.g. Pollock (1995) and Vreeswijk (1997), instead locate the defeasibility of arguments in the riskiness of their inference rules: in these logics inference rules are of two kinds, being either deductive or defeasible, and arguments can only be attacked on their applications of defeasible inference rules. Moreover, such attacks can have a weak or a strong form: weak attacks (which Pollock calls *undercutters*) only say that there is some exceptional situation in which the inference rule cannot be applied, without drawing the opposite conclusion, while strong attacks (which Pollock calls *rebuttals*) do draw the opposite conclusion.

For present purposes a combination of both approaches is needed, since as we saw above with the scheme from the position to know, presumptive arguments can be attacked both on their premises and (in a weak and strong form) on their presumptive inferences[1]. So from now on I will assume that arguments can be attacked in three ways: on their premises, on their inference and on their conclusion. If arguments consist of several inference steps, then the last two attacks may also be launched against an intermediate step in the argument. (Attacking an intermediate premise is the same as attacking an intermediate conclusion.)

What is the effect of these attacks on the justification of an argument? When one argument undercuts another then (other things being equal) we are clearly justified in accepting the undercutting and rejecting the undercut argument. However, with premise and rebutting attack this depends on an additional assessment of the relative strength of the two conflicting arguments. In many cases reasonable criteria are available for making such assessments. For example, sometimes a conflict between two contradictory applications of the position-to-know scheme can be adjudicated in terms of knowledge about the relative reliability of the witnesses or experts who are in the position to know. Similarly, two instances of the practical syllogism on how to achieve a certain goal might be compared on the positive and negative side effects of the two ways to achieve the same goal. Some argument-based logics even allow arguments on how other arguments should be compared.

This leads to an important notion of defeasible argumentation, namely the relation of *defeat* between conflicting arguments. Whatever conflict resolution criteria are appropriate, logically speaking we always end up in one of two situations: either the conflict cannot or it can be resolved. In the first case we say that both arguments defeat each other and in the latter case we say that the preferred argument defeats the other and not vice versa (or that the first argument strictly defeats the other). So 'X strictly defeats Y' means 'X and Y are in conflict and we have sufficient reason to prefer X over Y' while

[1]Recently I formalised such a combination in Prakken (2010).

'X and Y defeat each other' means 'X and Y are in conflict and we have no sufficient reason to prefer one over the other'. It should be noted that this binary nature of the outcome of the comparison does not preclude the use of comparative standards which are a matter of degree: even with such standards it must in the end still be decided whether a certain difference in degree is sufficient to accept one argument and reject the other.

However, the binary defeat relation between arguments is not enough to determine which arguments we can accept and which ones we must reject. Above I used the phrase "other things being equal" for a reason. Consider two rebutting arguments A and B based on two conflicting witnesses Alice and Bob. Even if, other things being equal, we would prefer Bob's testimony given that, say, he is an adult and Alice a child, the argument using Bob's testimony may be undercut by a third argument C expressing Carl's testimony that Bob's testimony is unreliable since he has a strong reason to hate the suspect. Then we have that B strictly defeats A but C strictly defeats B (since C undercuts B). Clearly in this case we are justified in accepting A and rejecting B even though B strictly defeats A, since A is 'reinstated' by argument C. This case is still intuitive but defeat relations within sets of arguments can be arbitrarily complex, so one cannot resort to intuitions and a calculus is needed.

What does this calculus look like? Currently there is no single universally accepted one and there is an ongoing debate in AI on what is a good calculus. However, for present purposes their differences do not matter: I therefore briefly sketch one simple and intuitive calculus that suffices for many applications, and which has the form of an *argument game* between a proponent and an opponent of an argument. (It is sound and complete for Dung's (1995) so-called grounded semantics.) Proponent starts the game with the argument to be tested and then the players take turns: at each turn opponent must defeat or strictly defeat proponent's last argument while proponent must strictly defeat opponent's last argument. Moreover, proponent is not allowed to repeat his arguments. A player has won if the other player has run out of moves. Now an argument A is *justified* if the proponent has a winning strategy (in the game-theoretic sense) in a game beginning with A, i.e., if he can make the opponent run out of moves no matter how she plays. In fact, the evaluation of arguments is three-valued: arguments that are attacked by a justified argument are *overruled* but sometimes two conflicting arguments are neither justified nor overruled, since they are equally strong and all other things are equal: then they are both *defensible*. Of course, all this is relative to a given information state. New information may give rise to new arguments that change the result. For example, new, previously unknown information may become available on the reliability of experts or witnesses, as in our above example of Alice, Bob and Carl.

The ideas can also be defined in terms of the so-called dialectical tree of all possible ways to play an argument game. The initial argument is *justified* if the proponent can choose his arguments in the dialectical tree in such a way that he always ends in a leaf with one of his own arguments. Figure 3 (taken from Prakken and Sartor, 2009) illustrates this calculus with an example dialectical tree. Each node in this tree is an argument. (The figure abstracts from their internal structure: in the simplest case an argument just has a set of premises and a conclusion, but when the argument combines several inferences, it has the structure of an inference tree as is familiar from standard logic.) Each link between two arguments is a defeat relation (mutual or strict depending on the arrows). Each branch of the tree is one way in which the game on proponent's top argument can be played. The colours have the following meaning. The idea (due to Simari et al., 1994) is to label all arguments in the tree as in or out according to the following definition:

1. An argument is *in* if all its counterarguments are *out*

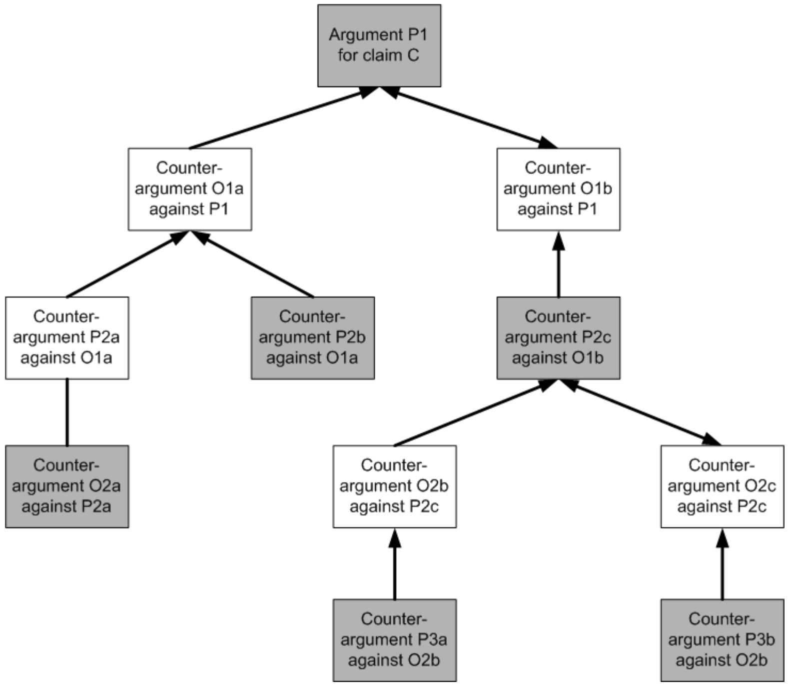

Figure 1: A dialectical tree

2. An argument is *out* if it has a counterargument that is *in*

In the figures *in* is coloured as grey and *out* as white. It is easy to see that because of (1) all leaves of the tree are trivially *in*, since they have no counterarguments. Then we can work our way upwards to determine the colour of all other arguments, ultimately arriving at a colour of the initial argument. If it is grey, i.e., *in*, then we know that proponent has a winning strategy for it, namely by choosing a grey argument at each point where he has to choose. If, on the other hand, the initial argument is white, i.e., *out*, then it is opponent who has a winning strategy, which can be found in the same way. So in Figure 3 proponent has a winning strategy, since he can always choose a grey reply and end up in a grey leaf node. To illustrate that all this is relative to a given information state, imagine that new information gives rise to a new defeater of P2b: then instead opponent could win.

4 The logic of argument schemes

In this section I give a logical account of argument schemes. I shall propose that argument schemes can be seen as defeasible inference rules and their critical questions as pointers to counterarguments. I shall then discuss two ways to formalise this proposal, and discuss an alternative logical account, in which argument schemes are types of generalised conditional premises of an argument.

4.1 Argument schemes as defeasible inference rules

As is hopefully clear by now, the concept of an argument scheme and a defeasible inference rule are very similar: both have premises and a conclusion, both are schematic instead of specific, and critical questions seem intimately related to the possibility of counterargument. The relation between the two concepts is particularly apparent in the work of John Pollock, e.g. (1987; 1995), who based his set of defeasible inference rules on general cognitive and epistemological principles, such as principles of perception, memory, induction and temporal persistence. Moreover, for each defeasible inference rule Pollock defined typical ways to undercut it, in the form of inference rules which specify circumstances under which the original inference rule does not apply. These undercutters are clearly close in spirit to some of the critical questions of argument schemes. Here are two examples. The first is Pollock's *perception principle*:

> R_1: Having a percept with content p is a reason to believe p.

Pollock (1987) formulates a general undercutter for perception, which I paraphrase as follows:

> U_{R1}: 'The present circumstances are such that having a percept with content p is not a reliable indicator of p' is a reason for not applying R_1.

Clearly, this undercutter is just the tip of the iceberg of theories on the reliability of perception. Pollock's favourite example of perceptual reasoning is: 'if an object looks red, it is red', which is undercut by 'the object is illuminated by a red light'.

Another example is Pollock's *memory* scheme:

> R_2: Recalling p is a reason for believing p.

for which Pollock (1987) defines the following two undercutters:

> U_{R2}: 'p was originally based on beliefs of which one is false' is a reason for not applying R_2.
> U'_{R2}: 'p was not originally believed for reasons other than R_2' is a reason for not applying R_2

(An aside: Bex et al., 2003 model reasoning with witness testimonies as a combination of Pollock's perception and memory schemes with Walton's position-to-know scheme. The reason is that the statement uttered by a witness is usually of the form 'I remember that I saw that q', so that to infer q from the witness statement, these three schemes must be successively applied.)

Now at this point my proposal for defining the nature of argument schemes should come as no surprise: argument schemes are defeasible inference rules and critical questions are pointers to counterarguments (I earlier defended this interpretation with others in Bex et al., 2003 and a similar account was given by Verheij, 2003a; 2003b). More precisely, the three kinds of attack on arguments correspond to three kinds of critical questions of argument schemes. Some critical questions challenge an argument's premise, others point to undercutting counterarguments, while again other questions point to rebutting counterarguments. The above position-to-know scheme only has questions of the first (1,3) and second (2) type. An example of a scheme that has questions of all three types is the *argument scheme from expert opinion* (cf. e.g. Walton, 1996; Godden and Walton, 2007):

$$\frac{\begin{array}{l} E \text{ is an expert in domain } D \\ E \text{ asserts that } A \text{ is true} \\ A \text{ is within } D \end{array}}{A \text{ is true}}$$

This scheme has six critical questions:

1. How credible is E as an expert source?
2. Is E an expert in domain D?
3. What did E assert that implies A?
4. Is E personally reliable as a source?
5. Is A consistent with what other experts assert?
6. Is E's assertion of A based on evidence?

Questions (1), (2) and (3) challenge a premise (respectively, the first and second premise), questions (4) and (6) point to undercutters (the exceptions that the expert is biased and that he makes scientifically unfounded statements) while question (5) points to rebutting applications of the expert opinion scheme. The Pollock-style undercutters corresponding to questions (4) and (6) are:

> U_E: 'E is not personally reliable as a source' is a reason for not applying the expert testimony scheme.
> U'_E: 'E's assertion of A is not based on evidence' is a reason for not applying the expert testimony scheme.

Actually, Pollock also regards each valid inference scheme from propositional or first-order logic as a reason, (which he calls *conclusive reasons*) and, to reflect the deductive nature of these schemes, he disallows any undercutting or rebutting attack on them. Accordingly, such reasons can (as also suggested by Verheij, 2003b) be regarded as argument schemes of which the only critical questions are whether their premises are true.

This logical account of argument schemes enables a simplification of the sets of critical questions of argument schemes (likewise Verheij, 2003a; 2003b). Since the kind of logic assumed in this paper allows for any premise and conclusion attack, critical questions that point at such attacks need not be explicitly listed but are automatically generated by the logic. Therefore, the only critical questions that need to be listed are those that point to specific undercutters. So the above version of the expert testimony scheme only needs questions (4) and (6).

4.2 An alternative logical account: argument schemes as generalised conditional premises

Before I further pursue the inference-rule interpretation of argument schemes, I must first discuss proposals to regard them instead as generalised conditional premises. Walton and Reed (2003) and Katzav and Reed (2004) add to each argument scheme a conditional premise *If other premises then conclusion* and then apply modus ponens to derive the conclusion. Katzav and Reed (2004) defend this treatment of argument schemes by saying that arguments express "relations of conveyance" between states of affairs instead of inferential relations between statements, so that argument schemes define types of conveyance relations.

To illustrate the difference with my inference-rule account, while I would formulate the scheme from the position to know as follows:

$$\frac{\begin{array}{l} a \text{ is in the position to know whether } A \text{ is true} \\ a \text{ asserts that } A \text{ is true} \end{array}}{A \text{ is true (false)}}$$

the alternative proposal is to formulate it as:

a is in the position to know whether A is true
a asserts that A is true
If a is in the position to know whether A is true, and a asserts that A is true, then A is true
———
A is true

Although at first sight, this alternative account would seem to preclude the need for defeasible inference rules, this is actually not true. Clearly, the 'if-then' in the latter version of the scheme cannot be a material implication, since the connection between the premises and the conclusion of the scheme is meant to be presumptive. So the conditional must be defeasible, which means that in this alternative account the logical nature of argument schemes boils down to the logical nature of defeasible conditionals. In particular, critical questions that in my inference-rule account point to undercutting, respectively, rebutting attacks must now be formulated in terms of a nonmonotonic-logic mechanism for handling exceptions to, respectively, conflicts between defeasible conditionals.

Now in the field of nonmonotonic logic many logics for defeasible conditionals have been developed, but a consensus is still far away. Moreover, unlike statements like 'birds fly' or 'the poor must be helped', argument schemes express general cognitive and epistemological principles, which makes it more natural to regard them as inference rules. Finally, in natural language argument schemes are almost never uttered as part of an argument, so that on the alternative account almost all natural-language arguments must be regarded as incomplete (likewise Govier, 1987). For all these reasons it seems more natural to regard argument schemes as (metalinguistic) inference rules.

Against this it might be argued that if argument schemes are formalised as inference rules, they can never be put into question as such (note that this is different from rebutting or undercutting them in specific situations, since such attacks still acknowledge the general plausibility of the attacked scheme). For example, it has been argued that witness statements are so often unreliable, that they should never be used to make inferences (Kaptein; 2009). If instead the scheme is regarded as a premise, it can always be challenged or attacked as such, so the argument goes. My response to this is that perhaps this can be used as a criterion for deciding what are argument schemes and what are (contingent) conditional statements: if of a candidate scheme it is rationally conceivable that it is challenged as such, regardless of specific facts, then it should be formalised as a conditional premise, while if this is not conceivable, it should be formalised as inference rule.

Summarising my account so far, there are two ways to regard argument schemes as logical constructs: as defeasible inference rules in a logic of defeasible argumentation, or as premise types in a nonmonotonic logic for defeasible conditionals. In both accounts critical questions reduce to three types of attack: in the first account on arguments, in the second on conditional premises. The state-of the art is that the inference-rule account is better formalised than the premise-type account, but this may, of course, change over time. I have given other reasons to prefer the inference-rule account, but they are more a matter of pragmatic convenience than of logical correctness.

4.3 Two ways to formalise the inference-rule account

In the remainder of this paper I will pursue the inference-rule approach to argument schemes. However, even within this approach there are two options for representing argument schemes, depending on whether the absence of exceptions is added as additional premises. Recall that there are three types of critical questions: those that ask whether a premise is true, those that ask whether there is an exception (undercutter) to the scheme and those that ask whether there is an argument with a contradictory conclusion (rebuttal). Sometimes the issue is raised whether critical questions of the second type point at implicit premises of the argument scheme.

Within the inference-rule approach, both answers to this question can be given a plausible formalisation (although again a negative answer seems closer to natural language). For instance, here is how the position-to-know scheme is formalised if the absence of exceptions is added to the premises:

$$\frac{\begin{array}{l} a \text{ is in the position to know whether } A \text{ is true} \\ a \text{ asserts that } A \text{ is true} \\ a \text{ is an honest (trustworthy, reliable) source} \end{array}}{A \text{ is true}}$$

The idea of this method is that undercutting attacks are reduced to premise attacks: for example, an argument that person a is dishonest now attacks the third premise of a position-to-know argument. This is a sensible idea, but it requires that two types of premises are distinguished. Since in the new method a positive answer to a type-two critical question is merely presumed, a counterargument that attacks such a presumption should always strictly defeat the argument using the scheme: no relative assessment should be needed to reach this conclusion. In the method that I have used so far, where positive answers to type-two questions are not added as premises, this result is automatically obtained, since undercutting counterarguments always strictly defeat their target. However, if undercutters are reduced to premise attacks then the problem arises that in the logics assumed in this paper the defeating nature of premise-attackers depends on a relative assessment of the premise and its attacker. So to retain in the new method the strictly defeating nature of negative answers to type-two questions, a second type of premise, which in Prakken (2010) I called *assumptions*, must be introduced in addition to ordinary premises. For example, in the new version of the position-to-know scheme the first two premises are ordinary ones, while the third one is an assumption. More importantly, the effect of a premise attack should differ as to whether an ordinary premise or an assumption is attacked: in case of attack on an ordinary premise a genuine choice must be made between the premise and the attacker, while attack on an assumption always succeeds, i.e. always leads to strict defeat, by the very nature of an assumption. (In the next section we will see that this difference is also required to give a proper dialogical treatment of critical questions.) The method with two types of premises is used in the Carneades system of Gordon et al. (2007). (It also has a third type of premise; see further Section 5.2.)

Again the choice between the two methods is a matter of pragmatic convenience instead of logical correctness. In fact, it is easy to show that the two methods are logically equivalent. The main pragmatic difference is that the original method seems closer to natural-language, since natural-language arguments seldomly make the presumed positive answers explicit. I will therefore below use the first method, but because of their equivalence everything will also apply in obvious ways to the second.

To end my logical account of argument schemes, I return to the issue discussed in Section 3 of how attack determines defeat, since the analysis of the present section allows me to make things more precise.

If two arguments rebut each other, then two things of the same kind oppose: two arguments that apply (possibly different) argument schemes to different premises, supporting contradictory conclusions. This attack is symmetric and should therefore be adjudicated on substantial grounds. So the defeat relations can go either way.

If one argument undercuts another one, then the one attacks a presumption of the other, namely a presumption that some exception does not arise. This is asymmetric attack: a presumption conflicts with evidence to the contrary, and the nature of presumptive reasoning then requires that the evidence to the contrary wins. So here the defeat relation always goes one way, from the undercutter to the undercut argument (except if two arguments undercut each other; for an example see Section 6).

Finally, what if one argument attacks a premise of another? Like undercutting attack, this attack is not symmetric, but unlike undercutting attack it is not automatically successful: whether this is so, depends on whether the attack is against an ordinary pemise or an assumption. So to know which argument defeats the other we must examine the nature of the premise: where does it come from, is it assumed or is it a hard fact? If it is assumed, then the attacker strictly defeats it by the nature of presumptive reasoning. However, if it is a hard fact, the answer depends on the reasons why we made it so. In a dialogical setting often further reasons for the attacked premise will be given: then the counterargument takes the form of a rebuttal of a subargument, and we are back to the first case. So in reality it will not often happen that premise attacks have to be adjudicated on substantial grounds: either the attack is on a assumption so automatically succeeds, or the attacked premise is supported by a further argument so that the conflict transforms into a rebutting attack.

To give an example, suppose the prosecution in a murder case wants to prove that the victim had a fractured skull since the suspect had hit him with an angular object, and uses the following argument (by Walton, 1996 called an argument from evidence to hypothesis):

> A fractured skull of this kind can be caused by being hit by an angular object
> A fractured skull of this kind was observed with the victim
> ---
> The victim was hit by an angular object

Suppose next that the defence challenges the first premises of this argument. Then the prosecution might answer with the following argument from expert testimony:

> The pathologist who investigated the victim said that a fractured skull of this kind can be caused by being hit by an angular object
> The pathologist is an expert on this matter
> ---
> A fractured skull of this kind can be caused by being hit by an angular object

Now a premise attack on the first argument is in fact a rebuttal of the second argument, which is a subargument of the first.

With these last observations we have reached the point that the use of argument schemes in dialogue must be discussed.

5 The role of argument schemes in dialogue

Above I agreed with Walton's view that fitting a recognised scheme is a necessary but not a sufficient condition for correctness of an argument. However, at first sight, Walton and I would seem to disagree on what else is needed. While I have argued above that an argument has to survive the *logical* competition with its counterarguments, Walton argues that an argument must survive a *dialogical* testing process with critical questions. So at first sight, Walton and I would seem to have incompatible views on the nature of argument schemes.

Yet there is a way to reconcile these two views. When above I said that an argument has to survive the competition with its counterarguments, I abstracted from the origin of the relevant counterarguments. Now one way in which these counterarguments can be identified is through a process of dialogue. This is one way in which dialogue is relevant for the justification of arguments. Another way in which dialogue is relevant for this purpose is that it provides additional ways to attack arguments beyond those provided by nonmonotonic logic. In particular, in dialogue an opponent of an argument could ask the proponent to provide further justification for an ordinary premise, and if proponent fails to provide such justification, opponent has defeated the argument without providing a counterargument. (Cf. the law, where in civil procedures plaintiff must usually provide evidence for any claim disputed by defendant on the penalty of losing on the issue.) To model such phenomena, we must move beyond logic and study dialogue systems for argumentation.

5.1 Embedding logic in dialogue systems

The formal study of dialogue systems for argumentation was initiated by Charles Hamblin (1970), and Doug Walton played an important role in its further development: see e.g. Woods and Walton (1978); Walton and Krabbe (1995). From the early 1990s several areas of computer science also became interested in the dialogical side of argumentation, such as artificial intelligence & law, multi-agent systems and intelligent tutoring. Of particular interest for present purposes are so-called persuasion dialogues, where two parties try to resolve a conflict of opinion. Dialogue systems for persuasion aim to promote fair and effective resolution of such conflicts. They have a *communication language*, which defines the well-formed utterances or speech acts, and which is wrapped around a *topic language*, in which the topics of dispute can be described. Walton and Krabbe (1995) call the combination of these two languages the 'locution rules'. The topic language is governed by a *logic*, which in argumentation theory is usually assumed to be standard, deductive logic, but which in AI & Law and MAS usually is a nonmonotonic one. The communication language usually at least contains speech acts for claiming, challenging, conceding and retracting propositions and for moving arguments and (if the logic of the topic language is nonmonotonic) counterarguments. It is governed by a *protocol*, i.e., a set of rules for when a speech act may be uttered and by whom (Walton and Krabbe, 1995 call them 'structural rules'). It also has a set of *effect rules*, which define the effect of an utterance on the state of a dialogue (usually on the dialogue participants' commitments, which is why Walton and Krabbe, 1995 call them 'commitment rules'). Finally, a dialogue system defines *termination* and *outcome* of a dispute. In argumentation theory the usual definition is that a dialogue terminates with a win for the proponent of the initial claim if the opponent concedes that claim, while it terminates with a win for opponent if proponent retracts his initial claim (see e.g. Walton and Krabbe, 1995). However, other definitions are possible. In my own work, e.g. Prakken (2005), I assume termination by agreement or external intervention, and I then define the outcome by applying an argument-based logic to the arguments exchanged in the dialogue. The benefits of such a definition will become apparent below.

Now what is important for us is that systems for persuasion dialogues allow for changing an information state by making new claims or stating new arguments (and sometimes by retracting earlier claims or arguments). This is an important respect in which dialogue systems go beyond the above logical account, which assumed a given and fixed information state. It is relevant for the evaluation of arguments in the following way. Since defeasible arguments can be defeated by counterarguments, the process of searching for information that gives rise to counterarguments is an essential part of testing an argument's viability: the harder and more thorough this search has been, the more confident we can be that an argument is justified if we cannot find defeaters.

Accordingly, a dialogue system for persuasion should be designed such that it furthers this goal: its speech acts should support changes of information states, and its protocol rules should promote that this happens in a fair and effective way. Dialectics is a driving principle here (Loui; 1998): when one side is wining, the resources should be given to the other side, to give it the chance to overturn this intermediate result. This is fair since both sides can have their say, and it is effective since it avoids one-sidedness and tunnel vision. It also allows us to give a combined logical and dialogical account of the burden of proof (Prakken and Sartor; 2009): if one side in a dialogue is winning in a certain information state (as determined by applying our argument-based logic to that state), the burden is on the other side to create a new information state where she is winning.

How do, on this account, logic and dialogue systems interact in the evaluation of arguments? In Prakken (2005) I proposed the following account (partly inspired by Gordon, 1994). The dialogical procedure provides the relevant arguments and counterarguments at each stage of the dialogue. Of those only the arguments that have no retracted premises and no challenged premises that are not supported by a further argument, are made input to the underlying logic. (An additional subtlety is that concessions raise the status of the conceded claim or premise to that of a hard fact). This logic then determines the justified arguments at that stage, after which the dialogical principle of dialectics shifts the burden of proof to the other side to make herself win at a new dialogue stage, and so on. Termination of a dialogue is largely governed by pragmatic considerations (how much time and other resources are left, how likely is it that new relevant evidence can be found?) and the ultimate justification of an argument is determined by applying the logic to the final information state. Thus the ultimate justification of an argument depends on both logic and dialogue, or more generally on both logic and investigation. This seems close to Walton's view, who in Godden and Walton (2007) says that evaluation of an argument is never complete until the dialogue itself is closed.

5.2 Argument schemes in dialogue systems

Let us against this background zoom in on the dialogical role of critical questions of argument schemes. Which of these questions should a dialogue system for persuasion allow? If we take the idea of argument schemes as presumptive forms of inference seriously, then it does not make much sense to allow critical questions that point to undercutters or rebuttals. Since argument schemes are presumptive inference rules, a negative answer to these questions is presumed and the opponent should present an undercutting or rebutting counterargument. So, for example, the opponent of an expert testimony argument should not just ask 'is the expert reliable?' or 'is the expert contradicted by other experts?' but present an undercutting argument for why the expert is not reliable or a rebutting argument that another expert said otherwise.

So in persuasion dialogue only critical questions that challenge a premise make sense (if the method with -type premises is chosen then this must be further restricted to ordinary premises). Now this type of question is, of course, already built into dialogue systems for persuasion as the possibility to challenge any premise of any argument. Therefore, such dialogue systems need no special provision for critical questions of argument schemes: questions of the first type are part of their general structure, and questions of the second and third type are catered for by the possibility of moving undercutting or rebutting counterarguments.

This analysis fits well with Walton's recent refined account of the dialogical effect of critical questions, according to which only critical questions that ask whether a premise of the argument is true create a burden on the other side to back the premise with further grounds, while critical questions that point at possible exceptional circumstances must be backed up with some evidence as to why the exception would be true; only if such evidence is provided, the burden of proof shifts back to the proponent of the original argument. This is perfectly captured in the present account. Firstly, a critical question that challenges an argument's (ordinary) premise removes the argument from the input of the logical testing procedure and so makes its proponent currently lose, so that the burden of proof shifts to him to provide a further argument for the challenged premise, after which it re-enters the logical testing procedure. Secondly, moving an undercutter or rebuttal (or an assumption attack) adds the moved argument to the input of the logical testing procedure and so makes its mover currently win, so that the burden shifts back to the other side (which can then either challenge a premise of the counterargument or move a counter-counterargument).

I end this section with a few asides on complicating factors. Firstly, sometimes the type of question or premise is not clear beforehand but can itself become the subject of a (meta-) dialogue (like the question of who has the burden of proof can be at issue in legal procedure). Prakken et al. (2005) present a dialogue system that allows for such metadialogues. It is more complicated than the usual ones, but the big picture still applies: first the dialogue outputs a set of arguments and counterarguments, then the logic is applied to draw conclusions from it, then the burden is shifted to the party who is currently losing.

Secondly, Gordon et al. (2007) refine the distinction between ordinary premises and assumptions with a third kind of premise called *issue*, which must always be backed with a further argument, even if it is not challenged. Before such further backing has been given, an argument with an issue premise will not enter the logical testing procedure at all. Issue premises occur, for instance, in legal procedures, where legal claims that are not backed by evidence are usually ignored. While this complicates the analysis, the big picture as sketched above still applies.

Finally, above I assumed that information on the relative strength of arguments (which as we saw is sometimes needed to determine defeat relations) is always available at the time the conflict arises. However, this is not always the case. For example, in legal procedure conflicts are usually not decided until after the adversaries have exchanged all their arguments and counterarguments; only then the trier of fact (judge or jury) adjudicates the conflicts. In Prakken (2008b) I studied so-called adjudication dialogues, a variant of persuasion dialogues where the adversaries try to persuade not each other but a neutral third party. Again the resulting dialogue system is more complicated, but again it still fits the big picture sketched above.

6 Argument schemes that compress reasoning methods

At this point the reader might think that I propose to regard all argument schemes as defeasible inference rules, to be treated as sketched above. However, this is not the case. Some argument schemes turn out to be abstractions of more complex lines of reasoning, which may not always be naturally reduced to reasoning with defeasible inference rules. I shall illustrate this with some fragments from a recent Dutch murder trial (profiting from a case study by Bex, 2009).

In this case the proof that the accused was guilty of murder involved various intermediate conclusions. One of them was that the victim's fractured skull and brain damage were both caused by being hit by an angular object. The court proved this from the statements of a pathologist, who had declared that a fractured skull like the one of the victim can be caused by being hit by an angular object, and that brain damage liked that of the victim can be caused by being hit by an angular object or by falling. Clearly, the court's proof combines several arguments from expert testimony with abductive causal explanations of the observed injuries. The expert testimony arguments are straightforward (one of them was listed above at the end of Section 4) but it is not immediately obvious how the causal reasoning can best be reconstructed. In fact, Walton has proposed various versions of his scheme for this kind of reasoning. In Walton (1996) he gives the following *argument scheme from evidence to hypothesis*:

If P is the case, then Q will be observed
Q has been observed

P is the case

which has the following critical question (in addition to those that ask whether the premises are true):

Could there be another reason why Q has been observed?

The court's explanation of the fractured skull easily fits this format (if we are willing to read 'P can cause Q' as equivalent to the first premise). It was listed above at the end of Section 4. However, the court's explanation of the brain damage contains a subtlety, since it states two possible explanations of the brain damage (being hit and falling) and then chooses the first without explaining why. Let us first reconstruct both possible explanations as an instance of the scheme from evidence to hypothesis:

Explanation 1:
Brain damage of this kind can be caused by being hit by an angular object
Brain damage of this kind was observed with the victim

The victim was hit by an angular object

Explanation 2:
Brain damage of this kind can be caused by falling
Brain damage of this kind was observed with the victim

The victim had fallen

Note that because of the critical question of the scheme, both arguments undercut each other, so that a choice has to be made. The reasons for the court's preference will be clear: if we accept explanation 2, then we must still also accept the conclusion of explanation 1, since the latter explains the other observed injury, namely, the fractured skull, while the 'falling' hypothesis does not explain the fractured skull. By contrast, explanation 1 explains both injuries. So by the principle of parsimony (explanations should be as simple as possible), which is generally accepted in any theoretical account of abductive reasoning, explanation 1 is preferred.

Both in AI and philosophy detailed formal and computational models of this kind of reasoning have been developed. All have the following general form of a two-steps procedure (though they may differ in detail): given a set C of causal generalisations and a set F of observed findings, in the first step all possible abductive explanations of F are constructed by identifying all H such that:

H combined with C implies F; and
H combined with C is consistent.

Then in the second step suitable preference criteria are applied to select the best explanation of F.

Now the point is that in our example this kind of reasoning is not most naturally modelled in the account that I gave in Sections 3 and 4: in an argument-based logic the two explanations of the brain damage undercut each other so it must be determined which one defeats the other. However, in doing so we above referred to a third argument: the 'hit' explanation of the brain damage was preferred since it also explains the fractured skull. Now in an argument-based logic this third argument, which explains the fractured skull, is fully unrelated to the two arguments explaining the brain damage. Only in abductive models as just sketched does this relation become apparent, since these require that *all* findings in F are explained by H. For this reason I will from now on refer to these models as 'global' models of abduction. The word 'global' is meant to contrast with the 'local' application of defeat criteria to binary conflicts between arguments in the argument-based model described in Sections 3 and 4.

The reader may think that an argument-based account can still be natural if the Q in the scheme from evidence to hypothesis is instantiated with

> A fractured skull *and* brain damage of this kind was observed with the victim.

However, this ignores that the court considered two possible explanations of the brain damage but only one of the fractured skull: so we cannot simply instantiate the second premise of the scheme with

> A fractured skull and brain damage of this kind can be caused by being hit by an angular object.

nor with

> A fractured skull and brain damage of this kind can be caused by being hit by an angular object or by falling.

So upon closer examination it turns out that the court did not really apply the scheme from evidence to hypothesis at all: instead, it seems that the conclusion that both injuries were caused by being hit was drawn on the basis of a global abductive reasoning process as just explained.

Interestingly, in later publications Walton proposed versions of an abductive reasoning scheme that better reflect the global nature of abduction. For example, Walton (2001) proposes the following *abductive argumentation scheme*:

F is a finding or given set of facts
E is a satisfactory explanation of F
No alternative explanation E' given so far is as satisfactory as E
____
E is plausible, as a hypothesis

with the following critical questions:

(1) How satisfactory is E itself as an explanation of F, apart from the alternative explanations available so far in the dialogue?
(2) How much better an explanation is E than the alternative explanations available so far in the dialogue?
(3) How far has the dialogue progressed? If the dialogue is an inquiry, how thorough has the search been in the investigation of the case?
(4) Would it be better to continue the dialogue further, instead of drawing a conclusion at this point?

To start with, it is important to see that the critical questions of this scheme differ in nature from those of all other schemes listed in this paper. Leaving the first two questions for a moment and focusing on the the third and fourth, we see that they are not typical for this particular scheme but are in fact a special case of the general embedding of nonmonotonic logic in dialogue systems that I proposed above in Section 5.1 (in fact, the same holds for the phrase "available so far" in the first two questions). So they should not be part of particular argument schemes, since they are automatically generated by a proper embedding of argument-based logic in dialogue systems. The same holds for Walton's tentative phrasing of the conclusion: by saying that E is plausible as a hypothesis, he wants to leave room for rejection of E after further investigation, but as explained above, this too is captured by the embedding of nonmonotonic logic in a dialogical context.

Moreover, the scheme itself is also different in nature from the schemes discussed above. To see this, let us reconstruct our example as an instance of this scheme. For the brain damage we obtain:

{ `fractured-skull`, `brain-damage` } is a given set of facts
{ `hit-by-angular-object` } is a satisfactory explanation of { `fractured-skull`, `brain-damage` }
{ `hit-by-angular-object` } is more satisfactory than all other explanations given so far
———
{ `hit-by-angular-object` } is plausible, as a hypothesis.

Now note that the second premise in fact compresses an application of Walton's original scheme from evidence to hypothesis (note that the causal generalisation has disappeared), while moreover, the third premise at once compresses all other constructed applications of that scheme (in our example just one but it could be any number) plus an application of preference criteria to make a choice between the alternative explanations. Note also that the critical question of the original scheme is now hidden in the third premise. So there seems no meaningful way in which this argument can be undercut or rebutted, since all conflict resolution is done inside the premises. In other words, this is not just a single argument but a compression of a more involved reasoning process.

In fact, we may say that the truth of the second and third premise of the argument is verified by applying definitions of a global model of abduction. To make this point more clear, let us see how a persuasion dialogue could evolve if the premises of this argument are challenged. Consider first a challenge of the second premise. Then a reply could be

We know that `hit-by-angular-object` can cause `fractured-skull`
We know that `hit-by-angular-object` can cause `brain-damage`
`hit-by-angular-object` combined with our causal knowledge implies both `fractured-skull` and `brain-damage`
`hit-by-angular-object` is consistent with our causal knowledge
———
{ `hit-by-angular-object` } is a satisfactory explanation of { `fractured-skull`, `brain-damage` }

This makes sense, but only since this argument is nothing but a restatement of the first step of the two-steps global model of abduction sketched above. Essentially, the argument restates the global model's definition of an explanation, so its justification derives from that definition.

Likewise for the argument that can be given to support the third premise. In fact, this argument is even more complex:

We know that `hit-by-angular-object` can cause `fractured-skull`
We know that `falling` can cause `brain-damage`
{ `hit-by-angular-object, falling` } combined with our causal knowledge implies both `fractured-skull` and `brain-damage`
{ `hit-by-angular-object, falling` } is consistent with our causal knowledge

{ `hit-by-angular-object, falling` } is a satisfactory explanation of
{ `fractured-skull`, `brain-damage` }
Moreover,
{ `hit-by-angular-object` } is more parsimonious than
{ `hit-by-angular-object`, `falling` }
More parsimonious explanations are more satisfactory

{ `hit-by-angular-object` } is more satisfactory than
{ `hit-by-angular-object`, `falling` }
Moreover,
No further explanations of { `fractured-skull`, `brain-damage` } have been given

{ `hit-by-angular-object` } is more satisfactory than all other explanations so far

This argument also derives its justification from being part of the global model of abduction: the first part restates the global model's definition of an explanation, while the second part applies the global model's preference criteria.

In sum, the arguments that can be given in support of the premises of Walton's new abductive argumentation scheme do not instantiate separate argument schemes but are part of a single global model of abduction. We can therefore conclude that the new scheme abstracts from, or compresses a complex reasoning form, hiding its internal structure.

But then the question arises why we would take this detour via constructing arguments at all. Why don't we directly apply the global model of abduction instead of decomposing it into separate arguments? Perhaps a proponent of argument schemes would say that such a decomposition allows us to apply the mechanism of critical questions to critically evaluate the arguments. However, if we look at these questions, we see that their nature has changed. We have already seen that the third and fourth question of the new abductive scheme are in fact special cases of a general way of embedding logic in a dialogical context. Moreover, its first two questions do not really point at exceptions to a defeasible rule: it is not generally presumed that if one explanation is better than another, it is better to a certain degree. Likewise for the degree of satisfactoriness of an explanation in itself. These things can just as well be dealt within a global model of abduction.

This leads to a generalised view on the relation between the logical and dialogical levels of persuasion dialogue. In Section 5 I embedded an argument-based logic in a dialogue system for persuasion, so that during a dialogue the participants in fact build a dialectical tree of arguments and counterarguments (which is then used to compute the intermediate or final outcome of the dialogue, according to the logic). However, we now see that sometimes the logic embedded in a dialogue system is of a different type: it can also be, for instance, a global logical model of abduction, so that during a dialogue the dialogue participants build a global causal model (which again can be used to compute the outcome of the dialogue, according to the abductive model).

This can be generalised even further. For example, in the Dutch murder case another intermediate conclusion was that a sledgehammer found at the crime scene had the victim's blood on it. This was proved on the basis of two estimates of conditional probabilities provided by DNA experts. Lack of space prevents me from analysing the court's statistical reasoning in detail, but here too it can be said that an argument-based reconstruction of the court's reasoning would conceal that the court actually applied a Bayesian model of this subproblem. So the 'logical' model that is built during a persuasion dialogue could be of any kind, as long as some notion of inference applies to it: it could be a logical, abductive, statistical, or even connectionist model (see Nielsen and Parsons, 2007 for a dialogue system for building a Bayesian network).

The Dutch murder case also motivates a final generalisation: since the court used different reasoning models on different subissues, the inferential model built during a dialogue in general consists of connected submodels of different kinds. Therefore, to compute the (intermediate or final) outcome on the final problem, we need a logical theory of combining different modes of reasoning. Recently, I proposed such a model in Prakken (2008a). Space does not permit me to give details here, but I hope that the above has convinced the reader that such a theory is needed.

Does all this mean that there is no place for argument schemes at all? On the contrary: in our murder example the input of both the abductive and Bayesian models was partly based on expert testimonies and witness testimonies, and this may well be modelled as argumentation with argument schemes. (Incidentally, this also shows that challenges of input elements of different reasoning models should be allowed.) Moreover, the output of an abductive or Bayesian analysis may be input to new a new reasoning process with argument schemes, for example with a rule application scheme as proposed by Gordon and Walton (2009). Indeed, in our murder case the court further used its factual conclusions to draw normative conclusions on the suspect's punishability and punishment. So in fact in our example the court combined three different kinds of reasoning: global abduction, Bayesian statistics, and reasoning with argument schemes.

Finally, I just said that we need a logical theory of combining different modes of reasoning. However, we also need a dialogical theory of how logical models of this kind can be built during dialogues, and how these models can be critically examined. A general theory is not yet available, but in Bex and Prakken (2008) a special case is developed for a combination of abductive reasoning and defeasible argumentation in the context of crime investigation: first a logical theory is defined of combined abduction and argumentation and then a dialogue system is defined for building a combined abductive and argument-based model of a criminal case.

7 Conclusion

In this article I have investigated the nature of argument schemes as they appear in the work of Doug Walton. Walton and I disagree in that while he regards argument schemes as dialogical devices, I have argued that they primarily are logical constructs and that their dialogical aspects are a special case of embedding an argument-based logic in a dialogical context. However, Walton and I agree in that we both hold that for an argument to be justified, it is not enough to fit a recognised argument scheme: it must also survive a critical testing process. Moreover, we agree that evaluation of an argument is not complete until this process is closed.

I have also argued that not all schemes appearing in the work of Walton are of the same logical nature: many can be regarded as defeasible inference rules in an argument-based nonmonotonic logic, but some appear to be compressions, or abstractions, of other kinds of reasoning. This calls for the need to study how different kinds of reasoning can be logically related and embedded in dialogue systems.

Finally, I do not claim that all argument schemes in the literature are of one of these two types: further investigation may reveal even more types of argument schemes. For example, maybe some can best be seen as templates for conditional premises (as in Katzav and Reed, 2004). And there may be still other kinds of argument schemes. At least I hope that the present investigation has convinced the reader that it is important to be aware that constructs that are presented in the literature as argument schemes may not always be of the same nature.

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