Argumentation Schemes in AI and Law

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Abstract. In this paper we describe the impact that Walton's conception of argumentation schemes had on AI and Law research. We will discuss developments in argumentation in AI and Law before Walton's schemes became known in that community, and the issues that were current in that work. We will then show how Walton's schemes provided a means of addressing all of those issues, and so supplied a unifying perspective from which to view argumentation in AI and Law.

Keywords: Argumentation schemes, AI and Law

1. Introduction

Walton's notion of argumentation schemes as set out in [97] and [104] has had a profound influence on AI and Law [13]. In this paper we will discuss the use of argumentation schemes in AI and Law, and show how various uses of argumentation schemes were affected by awareness of Walton's ideas. We begin by giving a brief overview of Walton's notion of argumentation schemes.

Walton's ideas about argumentation schemes developed from his work on fallacies. Logicians, who are interested in studying arguments that can be accepted as true from their form alone, have also investigated logical fallacies [62]: arguments that have a similar form but where the truth of the premises does not guarantee the truth of the conclusion. Thus Aristotle's study of the syllogism [7] was intended to show which forms of the syllogism led to valid arguments and which led to invalid arguments. Although interest in fallacies diminished as logical theory from the late nineteenth-century forward turned more and more to axiomatic systems and formal languages, in the second half of the twentieth century interest in fallacies returned as philosophers realised the uncomfortable fit between formal logic and natural language reasoning and argumentation. Walton was part of this revival, publishing a string of works on fallacies including [111], [112] and [107] amongst numerous others. Many fallacies have the form of a deductive argument, premises followed by conclusion, but they are not sound in that their premises may be true and yet their conclusion false. None the less, in practice, these forms of arguments are widely used, and often rightly accepted. Most arguments used in everyday discourse are not such as their premises entail their conclusions: the premises give reasons to believe the conclusion, and may allow us to *presume* that the conclusion is true. But this presumption is open to challenge, and must be withdrawn if it is shown that in the current context there are reasons to believe that the presumption does not hold. The everyday notion of arguments, and the predominant notion in legal argument, comes from their use in critical discussion, not in the demonstration of an unassailable truth.

An example of a fallacy is the *ad verecundiam* fallacy [111] which concerns appeals to authority or expertise. This fallacy can be expressed as an argument of the following form:

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E is an expert on subject *S*
E asserted that *A* is true
A relates to subject *S*
Therefore, *A* is true.

This is clearly not a sound argument: an authority may make a false statement about his subject for any of a number of reasons, in which case the premises will be true and the conclusion false. None the less, it is a form of argument that we commonly use and accept. Most of what we know was not discovered by us, nor incontrovertibly proven, but told to us by someone we regarded as an authority and who we believed was telling us the truth, having no reason to suppose otherwise. This observation, that certain types of argument give a presumptive reason to accept the conclusion in a given context where there are no reasons to disbelieve the conclusion, was the basis of Walton's notion of argumentation schemes. Argumentation schemes may be thought of as contextual forms of argument, where the conclusion of the argument is made more plausible or persuasive if the premises of the argument are believed or accepted to be true.

Thus use of the *ad verecundiam* argumentation scheme does not establish its conclusion as true, but gives a reason to presume that it is true, in the absence of any reason to think otherwise. In order to make the notion of *reason to think otherwise* concrete, Walton associated each of the schemes he identified with a set of characteristic *critical questions*, offering various possibilities as to why we might think otherwise. For example, we might associate the following questions with *ad verecundiam*. These are the critical questions given in [100], one of Walton's later discussions of this scheme:

AVCQ1 How credible is *E* as an expert source?
AVCQ2 Is *E* an expert in the field that *A* is in?
AVCQ3 Does *E*'s testimony imply *A*?
AVCQ4 Is *E* reliable?
AVCQ5 Is *A* consistent with the testimony of other experts?
AVCQ6 Is *A* supported by evidence?

There are a number of variations in the critical questions for this scheme: sometimes bias is explicitly mentioned, but here it is subsumed under AVCQ4. But the general idea is that there are a number of reasons why one might withdraw the presumption that *A* is true, but if none of these apply, *A* can be accepted.

If a critical question is posed, it casts doubt on the conclusion, but the presumption may be reinstated by giving a satisfactory answer to the question. Thus AVCQ2 could be answered by listing *E*'s qualifications, or track record. So we can see the argumentation schemes as providing a framework for critical discussion in which an argument is presented, questioned and defended. Many of Walton's schemes in [104] correspond to traditional fallacies, including several relating to the *ad verecundiam* fallacy (argument from expert opinion, argument from authority and argument from position to know). What the schemes add is the conditions under which the argument can properly be used to presumptively establish its conclusion.

Walton saw argumentation schemes as being within a dialogical context. Following this view, one could see the procedure for evaluating arguments as taking the form of a set of dialogue rules. However, as Prakken points out in [76] and [13], argumentation schemes can also be seen in another way. On this alternative view, argumentation schemes are essentially logical constructs, so that a procedure for evaluating arguments primarily takes the form of a logic. Prakken argues that most (though not all) argumentation schemes can be seen as defeasible inference rules and that their critical questions can

be seen as pointers to counter-arguments, so that the logic governing the use of argumentation schemes should be a logic for defeasible argumentation. On this view, the logical and dialectical aspects can be separated, as Prakken argued in [74], where he proposed three levels;

- A *generation*[1] *level* for the construction of arguments (here the instantiation of argumentation schemes and their critical questions);
- An *argument* level at which arguments can be assigned a status to determine which are acceptable (for example using Dung's argumentation frameworks [47] applying a particular semantics);
- A *dialectical* level, in which arguments are deployed to perform a task (e.g for a legal procedure such as pleadings [49], or deciding a case as in [30]).

In [76] Prakken also identifies a third way of viewing argumentation schemes, namely as a compressed way of expressing a particular method of reasoning.

In the remainder of this paper we will discuss the development of models of argumentation in AI and Law using Walton's account of argumentation schemes as a lens through which to view and compare various approaches. We will begin by discussing how argumentation was treated before Walton's understanding of argumentation schemes became widely adopted.

2. Standard Models of Legal Argumentation

The first International Conference on Artificial Intelligence and Law, held in Boston in 1987 is generally accepted as the starting point for the field of AI and Law. Although there had been some work in AI and Law before that, notably [70], [83] and [48], and there had been some small invited gatherings, this was where and when the international community as a whole first came together to exchange ideas. At that conference two distinctive models of legal reasoning were presented: what might be termed the *case based model*, described in [84] and the *rule based model* [34]. These two approaches represented different conceptions of argumentation.

2.1. The Rule Based Model

Although earlier legal systems had been built using production rules e.g. [110], rule based approaches were heavily influenced by systems such as [87] which saw them in terms of logical proof. In both the logical programming and production rule approaches, explanation followed the *how*? explanation pioneered by MYCIN [45], in which each conclusion established by a rule was explained by the truth of the predicates in the body of the rule, which were in turn explained by the rules used to establish them until the base level of facts was reached. The result is a tree with the conclusion as root, the facts as leaves, and between them a series of intermediate steps.

This tree can be interpreted as an argument, with each step a subargument. These arguments and subarguments are themselves of a single type, representing the success of a clause in the underlying program. They can thus be seen as a defeasible *modus ponens*: if the premises in the body of the clause are satisfied, the conclusion in the head of the clause can be drawn. The conclusion is, however, defeasible because of the use of negation as failure [63], so that something currently held to be false can be made true by the addition of a fact. An argument of this sort can be used to justify a position or to explain how

[1] This was called the *logic* level in [74], where Prakken envisaged the arguments being generated by a logic. We use *generation* level here to allow for arguments being generated by other means, for example by reasoning with cases.

the conclusion was reached, but it does not capture the dialectical aspects associated with argumentation, since no conflicting arguments are generated. In terms of Prakken's model we have the generation level, and a trivial evaluation level (where the generated argument is always true), but no dialectical level. It is missing the critical questions which are needed as "pointers to counterarguments", so that attacking arguments can be generated, and the critical discussion aspects of argumentation properly reflected.

To attempt to capture some of the dialectical aspects of argumentation, it was proposed by practitioners of this approach that multiple interpretations of the law or, in cases of uncertainty, multiple fact situations, could be represented in the program, so that several different, perhaps conflicting, arguments could be produced [36]. These counter agruments are, however, simply derivations of a contrary conclusion, and so lack the nuances of Walton's critical questions. Moreover, there is no longer an evaluation level: in [36] deciding between the different arguments was entirely a matter for the user. It was, however, suggested that an evaluation level could be supplied by encoding legal principles as meta-rules. The principle of *lex specialis* (prefer the more specific rule) was used in [73], while a variety or principles could serve as meta-rules in [86], including meta-meta rules to resolve conflicting meta-rules. This approach, however, lost favour as more sophisticated means of handing preferences in rule based systems such as using precedents [80] or values [35] were developed.

2.2. The Case Based Model

The case based model was introduced by HYPO [84], most fully described in [8]. HYPO gave rise to a long succession of influential programs, as described in [24]. At the heart of HYPO is its "three-ply" structure for presenting and responding to arguments. The three plies are:

(1) The proponent presents an argument
(2) The opponent responds to the argument
(3) The proponent attempts to rebut the response

This structure of argument is common in law, for example the oral hearings of the US Supreme Court [1], or the process of examination of witnesses in which the direct examination is followed by a cross examination and finally a redirect, which gives the lawyer representing the original party the opportunity to respond to any issues arising from the cross examination. This three-ply structure corresponds exactly to the structure of critical discussion found in the dialogical interpretation of Walton's argumentation schemes above: we have an argument, critical questions and answers to these questions. There was, however, no talk of argumentation schemes here: rather the approach thought in terms of *argument moves*, with a limited number of moves available at each ply. This is more in the spirit of a set of dialogue rules, as would be found in a purely dialogical approach such as, e.g. [75]. A set of such moves for use in CATO, which also adopted three-ply argumentation, was given in [3]. Each move was associated with a given ply:

(1) analogise to a precedent case with a favourable outcome;
(2) distinguish cited case; emphasise significance of a distinction; cite a counter example;
(3) downplay distinction; distinguish counter example; emphasise strengths; show weaknesses not fatal.

The emphasis of case based systems was thus at the dialectical level. HYPO and CATO were able to generate the arguments, but this was essentially done using algorithms to manipulate the case base, and these processes were not transparent to the user. Example algorithms are given in Appendix 3 of [2] and in [21]. Evaluation was left entirely to the user.

Thus in 1987 we find AI and Law addressing two key elements of Walton's argumentation schemes, the logical aspect and dialogical aspect. Each was being pursued separately to model different aspects of legal reasoning. In the next section we will look at some of the ways these ideas were developed prior to awareness of Walton's conception of argumentation schemes.

3. Developments in AI and Law prior to Walton's schemes

As more and more systems began to be produced using the rule based model, e.g. [42], [34] and [88], it became clear that the standard explanation facilities provided by rule based systems, the classic *why?* and *how?* explanations pioneered by MYCIN [45], were in need of improvement. The MYCIN style explanations were simply based on the proof trace of the solution, and so tended to be rather stilted, to contain an excessive degree of unnecessary detail (such as simple numerical comparisons, obvious to the users), and not to be organised in a way best suited to conveying the message to the user. This led to a desire to follow the structure of legal arguments more closely. A second problem was that the explanations did not naturally provide reasons why something could not be shown: because they used negation as failure, negative conclusions were based on the absence of proof, rather than a proof that could be presented to the user [28]. For case based systems, the dissatisfaction arose from a recognition that there were a number of characteristic legal arguments which were not really captured by the basic three-ply mechanism of HYPO [89], which modelled only the basic argument from precedent cases.

3.1. Richer Arguments

In this section we will describe the search for richer arguments first by considering the use of Toulmin's argument scheme [92] to represent the structure of arguments, and then by considering attempts to characterise the variety of types of argument that can be found in legal opinions.

3.1.1. Toulmin's Argument scheme

In the late 1980s several researchers independently came up with idea of using Toulmin's argument scheme to present legal arguments, including [66], [69] and [90]. Two of these were motivated by a practical need to explain their arguments to actual users; Lutomski [66] to explain his expert opinions as a forensic statistician to attorneys, and Storrs [90] by the need to explain the output of the logic models described in [20] to policy makers.

As Marshall expressed the problem in [69]:

> But there is more to a legal argument than reasoning or logic. Justices and attorneys bring an interpretive context, argumentative and rhetorical strategies, and other more general models of the domain and the world to an oral argument.

Toulmin represented arguments by the use of a number of components, shown diagrammatically in Figure 1. By identifying a number of different roles for premises, this scheme was able to include elements of context, in that the backing showed why the rule in the warrant was acceptable in the particular context, and elements of rhetoric in that a premise could be data, if it needed to be shown, or a rebuttal, if it could be assumed unless shown otherwise. Moreover some obvious premises, such as $70 > 60$ and the like, could simply be omitted, although they would form part of a *how*? explanation in a logic program. The diagrammatic presentation of the scheme was a feature which proved to be helpful in communicating with users as shown in [66] and [90].

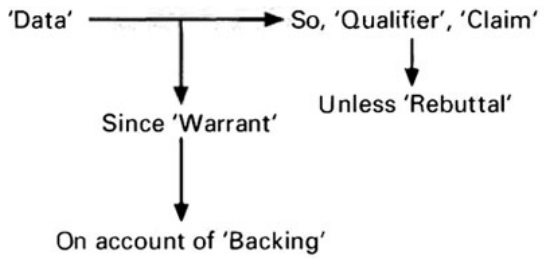

Fig. 1. Toulmin's Argumentation Scheme

In [29] a Prolog meta-interpreter was used to produce the output from an annotated logic program in the form of a set of relations describing Toulmin arguments. This was applied in [27] to provide an interactive explanation by traversing the links of Toulmin's scheme, in [37] to produce a structured report, and in [22] as the basis for the interactive discussion of a case. Toulmin's scheme was also used to explain the output from a neural network [115] and for the conceptual retrieval of legal cases [46].

3.1.2. Patterns of Argument used in Law

The widespread adoption of Toulmin's scheme revealed a need to represent more structure in explanations than is possible with a straightforward proof trace. The possibility of different patterns of arguments was explored in [89] and [65].

In [89], Skalak and Rissland set out to provide a (partial) inventory of forms of legal argument. These included some that were used in HYPO (analogising, distinguishing and make-weight), but also new forms such as *turkey, chicken and fish* (this turkey is not a fish so it should be treated as a chicken)[2], *throw the dog a bone* (concede a weaker position, but show the current case is stronger), *straw man*, *slippery slope* (concede this, and where can we stop?), *reductio*, *hedging* and *balancing* (where a pro reason must be weighed against a con reason). These arguments are all emerging from a case-based rather than rule-based representation: few of them can be considered logically sound and several of them are purely rhetorical. The balancing of reasons has, however, attracted a good deal of attention from more formally oriented researchers. Hage's Reason Based Logic [59] centered on this, and there have been various more recent approaches to the topic including [64], [31], [56] and [25], all of which offer different treatments of preferences and trade-offs.

Loui and Norman [65] also wished to distinguish different patterns of argument, but instead of looking at the arguments used by lawyers, they used logical analysis. Their key idea is that when a reason is offered for a conclusion, the reason *why it is a reason* might be one of a number of types. Thus, for example, we may have a *compression* rationale where the reason results from a compression of a more lengthy argument (giving the reason P for R, when the rationale is $P \rightarrow Q \rightarrow R$), or a *specialisation* rationale (giving P as the reason for R where $Q \rightarrow R$ and P is a specialisation of Q) and a number of others. The importance of these distinctions is that different rationales must be attacked in different ways: a compression rationale must be attacked by finding an invalid step in the chain whereas a specialisation rationale must be attacked by showing that the specialisation is inappropriate, for example by showing that Ps provide an exception to the general rule, as when Q is *bird*, P is *kiwi* and R is *flies*.

[2] An admittedly weak form of argument, for which Skalak and Rissland cite Frigaliment Importing Co. v. B.N.S. Int'l Sales Corp., 190 F.Supp. 116 (1980).

3.2. Dialogue

Also in the 1990s interest in dialogue began to develop. There were essentially three motivations for these dialogue systems:

- To provide a means of computationally establishing a fact, using a dialectical process which could involve different knowledge bases, or a system-user dialogue. Such dialogues had their origins in the dialogue games of logicians such as Hamblin [61] and Mackenzie [68]. These evolved into persuasion dialogues and were formally characterised in [75]. Such persuasion dialogues were also seen as a way of capturing the adversarial aspect of legal reasoning [79].
- For explanation, so that the users could specify what it was that they wanted to know instead of being swamped with too much detail. Several of these made use of Toulmin's scheme to structure the dialogue, including [27] and [37].
- To model a legal procedure, with the dialogue rules reflecting the rules of the legal procedure. A highly influential example was Gordon's Pleadings Game [49].

3.3. Representing Precedential Reasoning as Rules

During the early 90s, approaches based on rules and approaches based on cases were seen as separate, and even in conflict [38]. This was to change when a method for representing precedents as sets of rules was proposed in a paper by Prakken and Sartor [80]. The idea was to represent each precedent as modelled in CATO [2] as a set of three rules. In CATO precedent cases can be modelled as a triple $\langle P, D, O\rangle$ where P is the set of pro-plaintiff factors present in the case, D is the set of pro-defendant factors present in the case, and O is the outcome, either plaintiff or defendant. Now the strongest reason for the defendant will be represented by all the factors in P, the strongest reason for the defendant all the factors in D, and the outcome will show which of these reasons is preferred. Thus we can represent the case by three rules:

R1: $P \rightarrow \mathit{Plaintiff}$
R2: $D \rightarrow \mathit{Defendant}$
R3: $R1 \succ R2$ if $O = \mathit{Plaintiff}$ or $R2 \succ R1$ if $O = \mathit{Defendant}$.

Representing each precedent as three such rules enables a case base of precedents to be represented as a rule base, which was deployed using a dialogue game in [80], but which can be used in any system based on rules and priorities, such as ASPIC+ [71]. This paper had the important effect of enabling reasoning with precedents to be carried out using a rule based approach, and to make use of argumentation and dialogue tools available in the rule based context applicable to reasoning with legal precedents.

4. The Impact of Walton's Argumentation Schemes on AI and Law

From the previous section we have seen that towards the end of the last century there were a number of concerns under investigation by those interested in modelling legal argument:

- A desire to use a wider range of patterns of argument so that modelling legal argumentation could break the confines of defeasible *modus ponens* and make use of the wide variety of different argument patterns used in legal practice. For example [89] identified a number of such argument patterns. It is true that there was a tradition of the *rational reconstruction* of legal arguments as

deductive proofs in the jurisprudential literature (e.g. [4]), but not only is modelling argumentation as practiced by lawyers interesting in its own right, acceptability of systems to the legal profession, and the need for convincing explanations, required something more clearly resembling legal argument as used in practice. While Toulmin's scheme with its explicit representation of exceptions and backing had gone some way towards this, it still attempted to force the diverse patterns of argument found in law into a single mould. What was sought was a means of generating the variety of legal arguments, and a means of assessing which were sound.

- A desire to present legal reasoning in the form of an interactive dialogue.
- A desire to reflect the dialectical, adversarial nature of legal procedures. Note that the legal sense of "proof" is not the mathematical sense of proof, which is a coercive demonstration, but rather the older sense which denotes a test of acceptability using some agreed procedure.[3]

These *desiderata* provided an excellent context in which to introduce Walton's conception of argumentation schemes, since Walton's schemes provided a unifying framework in which to address all three of these concerns.

4.1. Representing a Variety of Patterns of Argument

This most obvious need satisfied by Walton's argumentation schemes was the provision of a number of patterns that could be used in legal argumentation, and so provide a better way to reflect legal practice. Argumentation schemes are identified by observation of natural argumentation, and any pattern of natural argument can be represented by an argumentation scheme. Thus it is possible simply to see schemes as providing a way to deploy a repertoire of the different patterns of argument found in legal discourse. This is the role given to them in work such as [53], in which the authors identified five schemes for legal reasoning:

- argument from position to know
- argument from ontology
- argument from rules
- argument from cases
- argument from testimonial evidence.

The schemes from rules and cases captured the style of argumentation used by the traditional approaches described in sections 2.1 and 2.2 respectively. The *position to know* scheme was used as generalisation of argumentation from authority and covered arguments based on commentaries. The *ontology* scheme covered arguments based on the interpretation of meanings (see 4.5 below for a discussion of statutory interpretation) and the final scheme allowed for witness testimony (see 4.4 below for a discussion of evidential reasoning). The approach of using a set of schemes to describe the reasoning in a case was applied in [55] to a case much discussed in AI and Law, *Popov v Hayashi*[4] [9].

Argumentation schemes provided both the means of generating and evaluating these various patterns of arguments, through the premises and conclusions of the schemes, and conditions under which they

[3] The old sense survives in terms like 40^o proof applied to spirits, which refers to the official procedure for determining alcoholic content.

[4] *Popov v Hayashi* concerns the disputed possession of a baseball, valuable because it had just been hit to set a home run record. The case is the subject of a 2004 comedy documentary *Up For Grabs*.

could properly be used through the critical questions. That argumentation schemes provide both guidance for constructing arguments and standards for their correct use is emphasised in [51]. Each of these aspects will be discussed in the following subsections.

4.1.1. Using Argumentation Schemes to Generate and Evaluate Arguments

The systematisation of natural patterns of arguments into schemes allowed for arguments to be generated from these schemes. The most straightforward approach was to simply encode each scheme as a special procedure. Thus, if using logic programming, one could encode argument from expert opinion, incorporating the critical question concerning bias as:

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holds(P,expertOpinion):- asserted(E,P),
                         expert(E,D)
                         inDomain(P,D),
                         not(biased(E)).
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This approach can also be used in the context of a framework such as ASPIC+ [71] by representing the various schemes as defeasible inference rules, as in e.g. [81].

This method of realising argumentation schemes requires that each scheme that is to be used needs to be individually hand coded. A more general approach is to build into the inference engine the ability to execute schemes in general. Thus one of the earliest proposals to use schemes in AI and Law, [94], advocated the use of argumentation schemes to specify a concrete logic which could then be embedded in DEFLOG [95] to produce an executable system. This approach was further developed in [96]. The most developed realisation of a system based on Walton's conception of argumentation schemes is Carneades, see [50] and [51][5], an integrated set of tools for argument (re)construction, evaluation, mapping and interchange. Carneades currently makes a library of 106 schemes available to its users [101], but this library can be extended if required by specifying additional schemes. Walton made extensive use of Carneades to illustrate his more recent work on argumentation schemes (e.g. [98], [99], and [102]).

Although Carneades does not produce an interactive dialogue with a user, rather generating both arguments and counter arguments itself and presenting its output as an argument graph similar to those pioneered in Araucaria [82], the dialogical aspects seen by Walton to be an essential feature of argumentation schemes are central to the way Carneades evaluates arguments. As noted in [96], critical questions can play several different roles. One role is to ask for support for some premise of the scheme: for example in the *ad verecundiam* argumentation scheme in section 1, AVCQ2, whether the person concerned is indeed an expert, requires the person putting forward the argument to offer evidence if challenged. On the other hand, ACVQ4 requires that the questioner provide some reason to believe that the expert is not reliable, such as evidence of bias. These different roles are reflected by three different types of premise in Carneades: *ordinary premises* which must always be supported by an argument; *assumptions*, which must be supported by an argument if challenged; and *exceptions*, which can be taken as false unless supported with an argument by the opponent. These distinctions enable Carneades to apportion the burden of proof [52]; for the *ordinary premises*, and any *assumptions* which are questioned, the burden of proof is on the original proponent while for the *exceptions* it is on the opponent. Another dialogical aspect, of particular significance in AI and Law, is the incorporation of proof standards in the evaluation [54]. Carneades allows the specification of several different standards of proof required for acceptance of a given argument, ranging from *scintilla of evidence* to *beyond reasonable doubt*.

[5]The current version of Carneades is publicly available at https://github.com/carneades. Last accessed 3rd November, 2020.

Approaches modelling schemes as defeasible inference rules, whether the particular approach of [81] or the more general approach of Carneades, operate with a conventional knowledge base of facts and rules: the argumentation schemes being represented as defeasible inference rules. An alternative approach applies the schemes not to a set of facts but to a model of the problem domain, similar to the way in which so-called "deep" models were used for qualitative reasoning [43]. An argumentation scheme for practical reasoning was presented in [16]. This scheme was developed from Walton's schemes for argument from good consequences and bad consequences [97] by adding social values to explain why the consequences were good or bad. A scheme using arguments from value was included in Walton's later book on argumentation schemes [104]. The scheme of [16] had been previously shown to be effective for modelling reasoning with legal cases [58] and for reasoning about policy in [57]. In [10] this scheme was giving a semantical underpinning in terms of a particular type of state transition diagram, Action-based Alternating Transition Systems [113]. The idea here is that the problem domain can be modelled as a state transition system, and the argumentation scheme and its critical questions instantiated in terms of the model. This approach was proposed as a means of considering policy decisions in [14], and the approach implemented in [109].

Thus the use of argumentation schemes can facilitate the implementation of a variety of patterns of argument systems using several approaches.

4.1.2. Proper Use of Patterns of Argument

Whilst the ability to provide the range of argument patterns used in actual legal argumentation is attractive, such a liberal approach encounters the problem that in practice people argue rather badly. Many of the arguments put forward in everyday debate are ill founded, unsound, or otherwise fail to support their conclusion. Indeed, as was noted in section 1, many of Walton's argumentation schemes themselves represent traditional logical fallacies. The key point of Walton's schemes, however, is that not only do they provide a means of employing various patterns of natural argument, but also that they provide a means of determining whether the argument pattern is being used properly, so that the argument can be considered acceptable, and so addresses the need to argue correctly as well. This brings to the fore the role of the critical questions: in order to be acceptable, an argument must be able to withstand the critical discussion represented by these questions.

In effect the critical questions provide a source of counter-arguments, which must be met if the argument is to be successful. Note, however, that posing a critical question may require some justification (if they are *exceptions* in Carneades). Thus if the truth of a proposition can be assumed under some argumentation scheme, questioning it requires some argument for its contrary. The endless repetition of the *why*? challenge that is possible under some of the logical dialogue games described in e.g. [75] is not licensed by this conception of critical question. Thus, in turn the arguments grounding the the critical questions can themselves be challenged using critical questions appropriate to the scheme used in that argument. We therefore are able to produce a series of arguments, counter-arguments, counter-counter-arguments, and so on. These can be grouped into an argumentation framework of the sort proposed by Dung [47], to evaluate which arguments are acceptable and which fail to withstand the critical discussion [93] and [44].

Thus Walton's account of argumentation schemes satisfies the need for a variety of argument patterns, in a way which can readily be used to generate arguments, while also, through counter-arguments based on the critical questions, supplying a means to evaluate their acceptability.

4.2. Designing Interactive Dialogues Based on Argumentation Schemes

Although the dialogical elements of argument, counter argument and rebuttal are present in any system based on argumentation schemes, some systems take the form of an interactive dialogue. During the 90s a number of legal dialogue games had been proposed to support this mode of interaction. As well as games designed to model a particular legal procedure [49], and those designed to resolve legal disputes [60] [79], there were also proposals for games designed to realise a particular argumentation scheme [22]. Walton's argumentation schemes readily lent themselves to realisation in this way. This is not surprising: Walton's conception of schemes was developed in the context of thinking about critical discussion, and he was always insistent of their dialogical aspects. A teleological justification of the use of argumentation schemes in dialogues was presented in [105].

Defining dialogue protocols requires the identification of a set of moves. If we have an argumentation scheme, these moves can be putting forward instantiations of the scheme itself, and then moves to enable instantiations of each of the critical questions to be proposed, and then moves to enable the critical questions to be challenged. Since the critical question must be backed by a reason, this will involve arguments using the same, or another, scheme, so that critical questions can in turn be used to rebut the question. Examples of dialogue games explicitly based on argumentation schemes can be found in [15], in which the dialogue is between the system and a user, and [108] in which the dialogue is between two software agents with different knowledge bases.

Such dialogues usually take the form of *persuasion* dialogues [103], with the underlying assumption that persuasion will be more effective if the persuadees are allowed to propose their own arguments which are met by the system, rather than simply being presented with a set of arguments. One area of application is e-democracy, in which policies can be defended against public critique, both in an effort to convince the public of the worth of the policies and to identify precisely which aspects of the policy are found objectionable. One such system is Parmenides [17] which is based on the practical argumentation scheme of [10]. In Parmendides the user is presented with a justification of a policy using the argumentation scheme and then encouraged to ask critical questions. The tool was later adapted [26] to allow the user to suggest a policy, being led through the construction of an argument following the practical reasoning scheme which was then critiqued by the system.

4.3. Argumentation Schemes for Modelling Procedures

As we saw in section 1, Walton's argumentation schemes can be seen in the context of dialogue, or as logical constructions useful for the evaluation of arguments, or, as identified in [76], as a means of encapsulating a method of reasoning to perform a particular task. We have dealt with the first two of these in the preceding subsections; in this subsection we will explore the potential for the third use. Prakken's own example in [76] was taken from law, namely reasoning abductively from evidence to a cause to determine the guilt or innocence of the accused. We can also see the practical reasoning scheme proposed in [10] in this way. This scheme combines a number of different elements: the facts true in the current situation, the causal effects of various actions, the goals that the agent has in the current situation, the values promoted by the goal, and preferences of the agent. All these various elements are compressed into a single argumentation scheme. A hint as to the complexity of this scheme is given by the number of critical questions: no fewer than 17 were identified in [10]. That it can be seen as a compression of a whole reasoning method becomes clear in [11] in which the original scheme is articulated into a set of schemes representing the various elements of that method which are brought together in the original scheme.

This aspect of argumentation schemes enables the third desire identified above, the desire to model legal procedures. For example the three-ply model of HYPO [84] lends itself well to a representation in the form of an argumentation scheme:

(1) The proponent begins by citing a precedent case which is similar to the current case, arguing that its decision should be followed.
(2) The opponent has two critical questions:
    (a) Distinguishing a case by asking whether there are relevant differences between the precedent and the current case;
    (b) Citing a counter example, by producing a precedent which is at least as similar to the current case but which has an opposite outcome.
(3) The proponent can now rebut, the nature of the rebuttal depending on the critical question posed in the second ply:
    (a) If a distinction is offered, that distinction can be downplayed by citing a relevant difference between the current case and the precedent which compensates for the difference cited by the opponent;
    (b) If a counter-example is offered, that can be distinguished by citing relevant differences between it and the current case.

These similarities were the basis for the representation of reasoning with precedent cases as a cascade of argumentation schemes in [114], in which distinctions were seen as of two kinds, depending on whether the precedent was stronger for the party using it, or whether the current case was weaker for that party. A Prolog implementation of this set of schemes was used in [23] to model the particular case of *Popov v Hayashi*. The schemes, were formalised in ASPIC+ in [81]. These schemes were extended to accommodate dimensions as well as Boolean factors in [18], and to accommodate values, as advocated in [39] and [35], in [33].

This method of articulating a reasoning task in terms of a set of argumentation schemes was applied to other areas, including democratic deliberation [32], Bayesian reasoning about evidence in criminal cases [77], hypothetical reasoning in law [31] and reasoning about the actions of others [12]. These examples show that providing a repertoire of dedicated argumentation schemes provides an effective way of specifying the procedures used to address a variety of reasoning tasks.

4.4. Argumentation Schemes for Reasoning About Evidence

Most of the work discussed above takes as its setting a higher order court where it is a point of law that is at issue and the facts are considered settled by the hearing at the lower court. However, there is a considerable body or work that does address reasoning with evidence and this has made use of argumentation schemes. An early use of argumentation schemes for this purpose was [41], which centred on the argument from expert opinion scheme for expert witnesses and the argument from witness testimony scheme for lay witnesses. Also used were schemes derived from Pollock's defeasible inference rules for epistemic reasoning [72], including perception, temporal persistence and statistical syllogism, to allow a finer grained examination of testimony. Two case studies were presented in [41] to illustrate the detailed use of the schemes in the context of real evidence. Bex went on to develop a hybrid theory of argumentation and stories, in which the argumentation schemes were augmented by a set of story schemes. He argued that a story-based approach works best for some points of a case, while for others

an argumentative approach is the most natural. Arguments and stories therefore should be combined into one hybrid theory, where stories are used to causally explain the *explananda* (facts to be explained) and arguments based on evidence are used to support and attack these stories.

A comparison of the hybrid and argumentation only approaches can be made by considering two studies of the Simonshaven case: [40] which uses the hybrid theory and [78] which uses an argumentation approach.

4.5. Argumentation schemes for Statutory Interpretation

Another specific reasoning task which has been addressed using argumentation schemes is statutory interpretation [85], [102], [116]. In [67] MacCormick and Summers identified eleven types of argument used when interpreting statutes. These included *Arguments from ordinary meaning*, suggesting that the statute be interpreted in accordance with the ways the terms are normally used, *Arguments from technical meaning*, allowing for technical meanings in appropriate contexts such as the regulation of a specialist activity, and *Arguments from contextual harmonization*, based on the need to consider particular passages in the light of the statute as a whole. An alternative approach was taken by Tarello [91], who listed fourteen canons for interpretation, including such things as *Arguments a simili ad simile* (argument from analogy) and *Teleological arguments*, whereby an interpretation is supported by the rationality of the purpose the law would serve if so interpreted. These lists can be seen as complementary since Tarello's focuses on the kinds of input on which the interpretive argument is based (ordinary language, technical language, statutory context, precedent, etc.) while that of MacCormick and Summers focuses on the reasoning steps by which the interpretive argument is constituted. With so many types of argument available, it is unsurprising that there will be conflicts and so a way of adjudicating the strength of the various argument types is needed. Some legal traditions have criteria for this: for example Aleey and Dreier identified eight such criteria [5] used in German law, such as that priority should be given to natural language over technical language in criminal law.

The argument types identified in [67] and [91] were used in [106] as the basis for a set of argumentation schemes for statutory interpretation. The schemes were classified into those that argued for an interpretation and those which argued against an interpretation. The positive schemes were further divided into arguments based on definition, analogical arguments, pragmatic arguments and arguments from authority. In all, sixteen positive and six negative schemes were identified. The schemes were then defined using premises, conclusions and critical questions as is usual for Walton's schemes. It was shown how the arguments could be evaluated using either ASPIC+ [71] or Carneades [52], and illustrated with a detailed case study.

Other work on statutory interpretation includes that of Zurek and Araszkiewicz [116] who also use agumentation schemes, although their approach is rather more abstract, and focuses on the problem of integrating interpretation with the entire argumentation process and the roles played by agents, rather than the structure of interpretive arguments. Araszkiewicz provides a full set of argumentation schemes and their critical questions is given in [6].

5. Concluding Remarks

In this paper we have examined how Walton's conception of argumentation schemes has made a significant impact in AI and Law. It has been shown that the problems that he addressed using argumentation schemes were already live issues in AI and Law, where there had long been an interest in modelling

the range of arguments employed by lawyers, exploring the dialectical nature of legal discourse, and accommodating the need to base arguments on cases as well as rules. Walton's schemes brought these hitherto diverse strands together: by offering the ability to generate and evaluate arguments of an extensible variety of forms, in a dialectical setting. One measure of their success is that the use of dialogue protocols to capture particular tasks involved in legal reasoning, which were highly popular in the 90s, has now almost disappeared in favour of using argumentation schemes for this purpose.

The advantages of using argumentation schemes are several:

(1) They enable the use of a highly descriptive set of arguments to reflect the actual practice of reasoning for this task;
(2) They cover normative aspects of the argumentation so that unsound arguments can be rejected through critical questions;
(3) They can be readily implemented by operating on a knowledge base or on a state transition model of the domain;
(4) They can be presented diagrammatically as a tree, or as a dialogue representing a persuasion or deliberation dialogue [19] to provide a more satisfactory interaction with users.

Dung's seminal work on abstract argumentation frameworks [47] transformed work on formal argumentation by providing a unifying perspective from which to view the problems of that field. But in many important areas, including law, politics, and ethics, it is necessary also to model the informal argumentation used in critical discussion. Walton's argumentation schemes provided the unifying perspective from which to view this area of research, complementing Dung's work on formal evaluation. Together, using argumentation schemes to build argumentation frameworks and Dung's methods to evaluate them, we have a powerful means of modelling all areas of human discussion.

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