



An exercise in formalising teleological case-based reasoning^{*}

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Abstract. This paper takes up Berman and Hafner's (1993) challenge to model legal case-based reasoning not just in terms of factual similarities and differences but also in terms of the values that are at stake. The formal framework of Prakken and Sartor (1998) is applied to examples of case-based reasoning involving values, and a method for formalising such examples is proposed. The method makes it possible to express that a case should be decided in a certain way because that advances certain values. The method also supports the comparison of conflicting precedents in terms of values, and it supports debates on the relevance of distinctions in terms of values.

1. Introduction

In his joint work with Carole Hafner, Don Berman presented several challenges to the AI & Law community. In Berman and Hafner (1987), they challenged the advocates of logic-based approaches to explain how logic can be applied to a field with so much vagueness and indeterminacy as the law. While in 1987 this challenge was fully justified, it was met by subsequent research on the application of nonmonotonic logics to legal reasoning. It was shown by e.g., Gordon (1995), Hage (1997), Prakken and Sartor (1996), Verheij (1996) and Prakken (1997) that logical models can also be applied when there is vagueness and indeterminacy. For a recent overview of this research see Prakken and Sartor (2001).

In their ICAIL-1993 paper, Berman and Hafner presented another challenge for AI & Law research, this time directed in the first instance to the case-based reasoning researchers in the field. Berman and Hafner argued that the then available case-based reasoning systems, especially HYPO (Rissland and Ashley 1987; Ashley 1990), were unable to generate 'deep' arguments of the kind lawyers produce, in terms of purposes, policies, interests and values. I think that AI & Law researchers widely agree that these elements indeed play an essential role in legal reasoning. However, systematic studies were and still are sparse, which justifies Berman and Hafner's challenge.

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Since 1993, however, new developments have opened the prospects for progress. For instance, HYPO's architecture has been extended into the CATO system (Alevén and Ashley 1997; Alevén 1997), which represents knowledge about the relations of relevant factors in a 'factor hierarchy', and which is able to generate arguments on the relevance of factors in terms of more abstract factors. And advocates of logical methods have attempted to capture aspects of case-based legal reasoning with the help of nonmonotonic logics. For instance, Hage (1997) has applied his reason-based logic (among other things) to HYPO-style case-based reasoning (an early version was Hage (1993), in the same proceedings as Berman and Hafner's paper!) And Giovanni Sartor and I have in Prakken and Sartor (1998) tried to capture HYPO-style case-based reasoning in terms of a formal dialogue system for defeasible argumentation. In the present paper I shall apply this system to teleological case-based reasoning.

Let me briefly summarise our (1998) proposal. We not only aimed to simply reconstruct HYPO's reasoning, but we also offered additional expressiveness, with the aim to capture more complex forms of case-based reasoning than can be performed by HYPO.

To start with, we could express multi-step relations between factors (as also in CATO's factor hierarchy). So where HYPO just says "*f* is a factor pro decision *d*", we could say "*f* is a factor pro *d* because it is an instance of *g* and *g* is a factor pro *d*".

Secondly, we gave a more general way to express the 'internal dialectics' of a case. While HYPO just separates the factors into pro-plaintiff and pro-defendant factors, we could represent decisions as a collection of possibly conflicting arguments of arbitrary complexity, by incorporating the argument-based defeasible logic of Prakken and Sartor (1996, 1997) in our proposal and using its expressiveness. This idea was inspired by Loui and Norman's (1995) idea to represent a case as a 'disputation tree'.

We also argued that HYPO's more-on-point priority relation between precedents is only one ground for comparing precedents, which can be overridden by other grounds. And we argued that a priority rule could be the final point of a very complex reasoning process, where all sorts of issues come into play. For these reasons we provided the means to model arguments *about* these priority relations. Thus we could, among other things, model the decision in a case with an explicit priority argument that decides the conflict between the various arguments pro and con.

Finally, we proposed to represent reasoning with precedents as argument moves in a dialogue game that is based on the dialectical proof theory of (Prakken and Sartor 1996). In particular, we modelled the analogising and distinguishing of precedents as 'theory constructors', i.e., as ways of introducing new information into a dispute, with which new arguments can be constructed.

Our examples in Prakken and Sartor (1998) mainly illustrated the points of multi-step arguments, the internal dialectical structure of cases, and analogising

and distinguishing precedents. However, at the end (p. 279) we also said the following:

Finally, the expressiveness of our rule language, which allows for rules about rules, opens prospects for representing teleological arguments, by which we mean arguments referring to the purposes of rules (...) However, we leave applications of this possibility to future research.

The present paper reports on an attempt to carry out this research suggestion and thus to meet Berman and Hafner's challenge. My claim is that much of their analysis of the well-known *Pierson*, *Keeble* and *Young* cases can be represented in the formalism of Prakken and Sartor (1998). More precisely, I shall formulate a value theory with which the decisions in these precedents can be explained, and which supports value-based argument moves on the comparison of conflicting precedents and the relevance of distinctions.

A qualification of this problem statement is in order. The main aim is to illustrate the expressiveness of the system of Prakken and Sartor (1998) by applying it to a new class of examples, and to propose a formalisation methodology for this class. It is not my aim to give a detailed logical reconstruction of the *Pierson*, *Keeble* and *Young* cases; rather, simplified interpretations of these cases serve as illustrations of the proposed methodology.

As for the structure of this paper, in Section 2 I present the material to be formalised, viz. a particular interpretation of the three precedents discussed by Berman and Hafner (1993). In Section 3 I briefly review the formal framework of Prakken and Sartor (1998), and in Section 4 I use this framework to formalise the material of Section 2. I then show in Section 5 how this formalisation supports some interesting value-based argument moves in disputes.

2. The material to be formalised

Berman and Hafner (1993) discuss three precedents that are often presented to American law school students, concerning the rights of hunters and fishermen against interference with their activities by others. In *Pierson* plaintiff was hunting foxes for sport on open land when defendant shot the chased fox and carried it away. The court held for defendant. In *Keeble* a pond owner placed a duck decoy in his pond with the intention to sell the caught ducks for a living. Defendant used a gun to scare away the ducks, for no other reason than to damage plaintiff's business. Here the court held for plaintiff. Finally, in *Young* both plaintiff and defendant were fishermen fishing in the open sea. Just before plaintiff closed his net, defendant came in and caught the fishes with his own net.

The task of the students is to argue for a decision in *Young* on the basis of *Pierson* and *Keeble*. If they follow a HYPO-style approach, comparing the cases on factual similarities and differences, then they will find it hard to find a ruling precedent. *Pierson* shares with *Young* that plaintiff was on open land and that he

had not yet caught the animal. Of these two factors, *Keeble* only shares the latter with *Young*, but in addition *Keeble* shares with *Young* that plaintiff was pursuing the animals for a living. So a HYPO-style more-on-point ordering does not prefer one precedent over the other.

However, Berman and Hafner convincingly argue that skilled lawyers do not confine themselves to factual comparisons, but often frame their arguments in terms of the values that are at stake.¹ For instance, plaintiff in *Young* could argue that people should be protected when pursuing their livelihood, since society benefits from their activities. Plaintiff could use *Keeble* as support, arguing that this was the reason why *Keeble* was decided for plaintiff, as the following quotations (taken from Berman and Hafner 1993), illustrate.

[W]here a violent or malicious act is done to a man's occupation, profession or way of getting a livelihood, there an action lies in all cases.
(...)

And when ... decoy[s] have been used ... in order to be taken for profit of the owner of the pond ... and whereby the markets of the nation may be furnished; there is great reason to give encouragement thereunto ...

And defendant in *Young* could argue that since plaintiff had not yet caught the fish, he had no right to the fish, since if such rights depended on who first saw the animals, there would be no clear criterion and the courts would be flooded with cases. Thus defendant argues that deciding for him promotes the value of legal certainty. He can use *Pierson* as support by arguing that this was also why *Pierson* was decided for defendant, as suggested by the following quotation.

[We so hold] for the sake of certainty, and preserving peace and order in society. If the first seeing, starting, or pursuing such animals ... should afford the basis of actions ... it would prove a fertile source of quarrels and litigation.

Alternatively, defendant could argue that not only plaintiff but also defendant was pursuing his livelihood, and that society benefits from economic competition.

As Berman and Hafner (1993) observe, several interpretations of the cases are possible. In fact, precedents often do not clearly reveal the reasons for their decision, and one skill of good lawyers is to interpret a precedent in a way that best suits their client. However, modelling such skills goes beyond the topic of this paper (see also Section 6 below). I have therefore chosen one particular interpretation, which largely follows the one of Bench-Capon (2001), and which seems in agreement with the written decisions of the precedents.

More precisely, I assume that three values are at stake in these cases, viz. economic benefit for society, legal certainty, and also the protection of property. The latter value can be used by the plaintiff in cases where he had already caught the animals, or where he was hunting on his own land. As for the decisions in the precedents, I shall assume that *Pierson* was decided for defendant to promote legal certainty and since no values are served by deciding for plaintiff: he was not hunting for a living so economic benefit would not be advanced, and he had not yet

caught the fox and was hunting on open land, so there are no property rights to be protected. Further, I assume that *Keeble* was decided for plaintiff since the value of economic benefit is more important than the value of certainty. Thus *Keeble* also reveals part of an ordering of the values. Finally, in my interpretation of *Pierson* and *Keeble*, *Young* should be decided for defendant: the value of economic benefit does not support plaintiff since defendant was also fishing for his living, the value of protecting property does not apply since plaintiff had not yet caught the fish and was not on his own land, so the only value at stake is certainty, which is served by finding for the defendant.

I now list this interpretation in a more schematic way. The material to be formalised consists of

- The relevant factors and their tendency towards one of the parties;
- The cases in terms of the present factors and their decision;
- The relevant values;
- How case decisions advance values;
- The relative importance of values.

Relevant factors

The relevant factors are as follows:²

- Whether or not the plaintiff was pursuing his livelihood; (\neg) *PLiving*.
- Whether or not the plaintiff was hunting on his own land; (\neg) *OwnLand*.
- Whether or not plaintiff had caught the animal(s); (\neg) *Caught*.
- Whether or not defendant was pursuing his livelihood; (\neg) *DefLiving*.

As for the tendency of factors, I assume that *PLiving*, *OwnLand* and *Caught* are pro-plaintiff factors and that *DefLiving* is a pro-defendant factor. I also assume that the opposite of a pro-party factor favours the other party (for instance, \neg *PLiving* is a pro-defendant factor); this is just one possible interpretation of the cases, which is not essential for the representation method proposed below.

The cases

In all three cases, plaintiff is the one who seeks relief against the interference with his actions, and defendant is the interfering person.

Pierson:

- Plaintiff was not pursuing his livelihood (\neg *PLiving*)
- Plaintiff was not on his own land (\neg *OwnLand*)
- Plaintiff had not caught the animal (\neg *Caught*)
- Defendant was not pursuing his livelihood (\neg *DefLiving*)

Decision: for defendant.

Keeble:

- Plaintiff was pursuing his livelihood (*PLiving*)
- Plaintiff was on his own land (*OwnLand*)

- Plaintiff had not caught the animal (\neg *Caught*)
- Defendant was not pursuing his livelihood (\neg *DefLiving*)

Decision: for plaintiff.

Young:

- Plaintiff was pursuing his livelihood (*PLiving*)
- Plaintiff was not on his own land (\neg *OwnLand*)
- Plaintiff had not caught the animal (\neg *Caught*)
- Defendant was pursuing his livelihood (*DefLiving*)

Decision: for defendant

Values:

I assume that the following values are at stake.

- Certainty and avoidance of litigation (*Cval*)
- Economic benefit for society (*Eval*)
- Respecting property (*Pval*)

How case decisions advance values

I first list how decisions based on individual factors relate to values.

- Deciding for plaintiff because of *PLiving* advances *Eval*.
- Deciding for plaintiff because of *OwnLand* advances *Pval*.
- Deciding for plaintiff because of *Caught* advances *Pval*.
- Deciding for defendant because of \neg *Caught* advances *Cval*.
- Deciding for defendant because of *DefLiving* advances *Eval*.

Next, as for combinations of factors, I simply combine the above observations. For instance, deciding for plaintiff because of *PLiving* and *OwnLand* advances the values *Eval* and *Pval*.

Note that in my interpretation not all decisions based on factors promote values. For instance, deciding for defendant because plaintiff was not pursuing his livelihood (\neg *PLiving*) does not promote any of the three values.

Actually, in many cases it will be debatable whether a certain decision advances a certain value. This paper's framework supports debates on such issues (cf. Section 4.1 below), but for simplicity I assume that they do not arise.

The relative importance of values

For simplicity I assume that protecting property (*Pval*) is the most important value, then comes economic benefit for society (*Eval*) and then legal certainty (*Cval*). Again, in many cases the value ordering could be disputed and such debates can be modelled in the present framework (cf. Section 4.2 below). But again I will ignore this complication for simplicity.

3. The formalism

The formalism to be used below is that of Prakken and Sartor (1998). It consists of four parts: a logic for defeasible argumentation, a way of representing precedents in the logic, a ‘dynamic’ argument game that allows for the introduction of new information into a dispute, and two ‘theory constructors’ for doing so by way of analogising or distinguishing precedents.

3.1. THE LOGIC

The 1998 system builds on the logic for defeasible argumentation developed earlier in Prakken and Sartor (1996, 1997). Its language is that of extended logic programming. However, for present purposes some extra expressive power is needed. Therefore I will use my generalised (1997) system, which extends the 1996 language to, roughly, that of default logic.

More precisely, the ‘input’ information is represented in a set \mathcal{F} of first-order formulas, divided into the necessary facts \mathcal{F}_n and the contingent facts \mathcal{F}_c , and a set Δ of defaults, or defeasible rules. The information in \mathcal{F} is beyond debate; only defeasible rules can make an argument subject to defeat. In the full system defeasible rules can contain weakly negated formulas (assumptions). However, for present purposes they are not needed, for which reason I ignore them below. Defeasible rules are then of the form $r: A \Rightarrow C$ where A and C are first-order formulas. Each defeasible rule is prefixed with a term, its name.

Arguments are chains of defeasible rules ‘glued’ together by first-order inferences. Arguments using defeasible rules can be attacked by arguments with a contradictory conclusion. Conflicting arguments are compared with the help of rule priorities, which induce a binary relation of *defeat* among arguments. This is a weak notion in that two arguments can defeat each other. This happens when a rule conflict is not resolved by the given rule priorities. If one argument defeats the other but not vice versa, we say that the first *strictly defeats* the second.

An important feature of the system is that the information about the rule priorities is itself presented as premises in the logical language. Thus rule priorities are like any other piece of legal information established by arguments, and may be debated as any other legal issue.

Finally, the output of the logic is a classification of all constructible arguments as ‘justified’, ‘overruled’ or ‘defensible’. The status of arguments is defined in the dialectical form of an argument game, where the proponent starts with an argument, and then both players try to defeat each other’s arguments. The initial argument is *justified* if the proponent has a winning strategy in such a game, i.e., if he can make the opponent run out of moves in whatever way the opponent plays; an argument is *overruled* if it is defeated by a justified argument, and it is *defensible* otherwise.

3.2. A METHOD FOR REPRESENTING GASES

The 1998 paper also proposed a particular way to represent precedents in the logic. The general idea was to represent them as a set of arguments pro and con the decision, and to capture the decision by a justified priority argument that in turn makes the argument for the decision justified. (In displaying cases usually only the rules giving rise to the arguments will be shown.) In its simplest form where, as in HYPO, there are just a decision and sets of factors pro and con the decision, this amounted to having a pair of rules

$$r_1 : \textit{Pro-factors} \Rightarrow \textit{Decision}$$

$$r_2 : \textit{Con-factors} \Rightarrow \neg \textit{Decision}$$

and an unconditional priority rule

$$p : \Rightarrow r_1 \succ r_2$$

which declares r_1 to be the ‘winning’ rule of the case. However, we remarked that the priority $r_1 \succ r_2$ could very well be the justified outcome of a competition between arguments. It is this possibility that I want to exploit in the present paper. On the other hand, I will keep the ‘factor rules’ of cases as simple as r_1 and r_2 .

3.3. THE DYNAMIC ARGUMENT GAME AND THEORY CONSTRUCTORS

The argument game of the logic is static, in that it assumes a given set of premises. However, in real disputes parties often introduce new information during the dispute. Therefore, the 1998 paper dropped the assumption of fixed premises. In that paper, the main application of this idea was the formalisation of HYPO-style analogies and distinctions as heuristics for introducing new information. Analogy is captured by the possibility to broaden the case’s factor rule that favours the desired outcome by deleting its antecedents that are missing in the new case. Distinguishing is captured in two ways. If the new case lacks factors of the precedent, then it is possible to introduce a conflicting rule “if these factors are absent, then the consequent of your broadened rule does not hold”. And if the new case contains new factors favouring the losing side in the precedent, then it is possible to use a rule “if these factors are present, then the consequent of your broadened rule does not hold”.

4. The formalisation

I shall now formalise the material of Section 2 in the formalism of Section 3. In this section I confine myself to representing the grounds for individual decisions. The discussion of possible argument moves in disputes will take place in Section 5.

First I develop a theory on how value considerations give rise to arguments for rule priorities. Then I represent the three precedents in the simple way explained above, viz. with two conflicting factor rules and an unconditional priority rule. Finally, I shall show how these unconditional priorities are implied by the value theory.

A note is in order on what is assumed familiar to the reader. Below I say at several places without detailed explanation that my approach supports debates on certain issues. In fact, such debates can be supported by expressing information on debatable issues as defeasible rules, so that arguments using them become subject to defeat by counterarguments. The precise mechanisms are explained in Prakken and Sartor (1996, 1997), and are assumed familiar to the reader.

4.1. THE FORMALISATION METHOD

Berman and Hafner represented values as follows. While HYPO simply relates factors to a decision (pro or con), they linked factors to the values they advance, and they linked values in turn to decisions. This method can be directly used in Prakken and Sartor's (1998) multisteps arguments (and also in CATO's factor hierarchy). However, in the present paper I will, following Sartor (2001), take another approach, which relates factors-decision pairs to values. Instead of saying "the presence of factor f in case c advances value v ", I will say "deciding case c with decision d because of factor f advances value v ". For instance, I shall not say that the fact that plaintiff was pursuing his livelihood, advances economic benefit for society; instead I shall say that deciding *Keeble* for plaintiff because plaintiff was pursuing his livelihood, advances economic benefit for society.

More specifically, if a decision d because of factor f is expressed with a rule

$$r : f \Rightarrow d$$

then I express the opinion that taking decision d advances value V as follows in \mathcal{F}_c

$$\text{Advances}(r, v).$$

Here I exploit the fact that our language contains rule names as terms and thus allows the expression of information *about* rules.

In Section 2 I mentioned that the framework supports debates on whether a decision advances a certain value. This can be achieved by instead using a defeasible rule³

$$r' : \Rightarrow \text{Advances}(r, v).$$

Then any argument using rule r' can be attacked by a counterargument for the conclusion $\neg \text{Advances}(r, v)$.

That a decision advances more than one value can be expressed by using several rules of the above form. For instance, if the above rule r' advances not only value v but also value v' , it can be split into two rules

$$r' : \Rightarrow \text{Advances}(r, v)$$

$$r'' : \Rightarrow \text{Advances}(r, v').$$

Next the information on the value(s) advanced by a rule is used to state priorities between rules: the more important the set of values advanced by a rule, the higher its priority. The value-based rule priorities are then used to explain the decisions in the three precedents.

4.2. THE ‘HARD’ FACTS AND RULES

The necessary facts \mathcal{F}_n include the equality axioms and some definitions related to ordering predicates, such as those of a strict partial order. Some further necessary facts will be specified below. The contingent facts \mathcal{F}_c state which values are advanced by which rules. \mathcal{F}_c also contains an ordering of the three values. (Again, if this ordering is regarded as debatable, it can instead be expressed as a defeasible rule, in the manner just explained.)

$$f_{valord} : Pval \succ Eval \succ Cval.$$

Finally, \mathcal{F}_c contains the facts of the current case.

4.3. THE DEFEASIBLE INFORMATION

Since value considerations might be overridden by other grounds, such as a court’s authority, a decision’s recency, or similarity considerations, the value theory is expressed as defeasible rules. We want to compare rules in terms of the values they advance, so we must collect all values advanced by a certain rule in the rule’s ‘value set’, and then compare the value sets of conflicting rules in terms of our ordering of the individual values.

To formalise this, I first add a rule Val_{comp} that orders sets of values in terms of an ordering on their elements. Such a comparison can, of course, be made in many ways; the exact way is not essential for the present formalisation method. Here I use a method that is often used in nonmonotonic logics when models are compared on how well they satisfy a set of defaults; see e.g., Geffner and Pearl (1992). In words, this definition says that $Values_1$ is better than $Values_2$ if for every $Values_2$ -value missing in $Values_1$ there is a better $Values_1$ -value missing in $Values_2$.

$$\begin{aligned} Val_{comp} : \\ & \forall values_1, values_2 [\forall v_2 ((In(v_2, values_2) \wedge \neg In(v_2, values_1)) \\ & \rightarrow \exists v_1 (In(v_1, values_1) \wedge \neg In(v_1, values_2) \wedge v_1 \succ v_2)) \\ & \Leftrightarrow values_1 \succ values_2] \end{aligned}$$

($A \Leftrightarrow B$ is a shorthand for two rules $A \Rightarrow B$ and $\neg A \Rightarrow \neg B$). Note that this definition implies that if one value set is a proper subset of another, the latter set is better.

Recall that a value set contains the values advanced by a given rule. Accordingly, individual value sets will be denoted by terms $Values(r)$. Now how does a value become included in a value set? This happens if it can be derived that the value-set's rule advances the value. So we must also have the following definition in \mathcal{F}_n .

$$f_{valsets} : \forall r, v (In(v, Values(r)) \equiv Advances(r, v)).$$

However, there is a subtlety here. Suppose that we know (as a matter of fact or by derivation) that rule r_1 advances value $Cval$ but we know nothing about whether r_1 also advances $Eval$ and/or $Pval$. Then we want that the value set of r_1 only contains $Cval$. In other words, we want to express that those values of which it can be derived that they are advanced by r_1 are the only values advanced by r_1 . This amounts to a 'closed world assumption' for the advancement of values by rules. One way to express it, is to add to Δ a default of the form

$$r_{noadv} : \Rightarrow \neg Advances(r, v).$$

This default says of any rule r and value v that r does not advance v . It should be given the lowest possible priority, so that it is overridden by any conclusion that a particular rule advances a particular value.

Now we come to the central element of the value theory, the ordering of rules in terms of their underlying values.

$$Val_{pr} : Values(x) < Values(y) \Rightarrow x < y.$$

It is this rule that enables a value-based comparison between conflicting arguments.

To illustrate that value considerations can interfere with HYPO's more-on-point ordering, I also include the more-on-point priority default mop from (Prakken and Sartor 1998).

$$mop : More-on-point(Prec_1, r_1, Prec_2, r_2) \Leftrightarrow r_2 < r_1.$$

This rule gives priority to citations of more-on-point precedents over citations of less-on-point precedents. The interference of these two priority rules must be regulated. Different opinions might be possible here; I shall simply assume that value considerations always override the more on point ordering:

$$R_{valmop} : mop < Val_{pr}.$$

However, the formalism supports more refined opinions. For instance, if one regards the value ordering as more important than similarity just in case the similarity is not strong, then the following two rules can be used.

$$R_{valmop_1} : VerySimilar(Prec_1, r_1, Prec_2, r_2) \Rightarrow mop < Val_{pr}$$

$$R_{valmop_2} : \neg VerySimilar(Prec_1, r_1, Prec_2, r_2) \Rightarrow mop \prec Val_{pr}.$$

Of course, this leaves the question how to define *VerySimilar*.

4.4. THE CASES

I now come to the cases. In addition to the factor and priority rules I also indicate which values are advanced by the factor rules. Recall that the latter information is in the contingent facts \mathcal{F}_c . Below P = ‘case held for plaintiff’, D = ‘case held for defendant’. To make rules for P and D conflicting, we must add the formula $P \Rightarrow \neg D$ to the necessary facts \mathcal{F}_n .

Pierson:

$$\begin{aligned} p_1 &: \neg DefLiving \Rightarrow P \\ p_2 &: \neg PLiving \wedge \neg OwnLand \wedge \neg Caught \Rightarrow D \quad (Cval) \\ pr_1 &: \Rightarrow p_2 \succ p_1. \end{aligned}$$

Keeble:

$$\begin{aligned} k_1 &: PLiving \wedge OwnLand \wedge \neg DefLiving \Rightarrow P \quad (Eval, Pval) \\ k_2 &: \neg Caught \Rightarrow D \quad (Cval) \\ pr_2 &: \Rightarrow k_1 \succ k_2 \end{aligned}$$

Young:

$$\begin{aligned} y_1 &: PLiving \Rightarrow P \quad (Eval) \\ y_2 &: \neg OwnLand \wedge \neg Caught \wedge DefLiving \Rightarrow D \quad (Cval, Eval) \\ pr_3 &: \Rightarrow y_2 \succ y_1. \end{aligned}$$

4.5. DERIVING THE CASE DECISIONS FROM THE VALUE THEORY

In most examples of Prakken and Sartor (1998) the decision of a case was simply expressed as above, viz. as an unconditional priority between the conflicting rules of the case. However, with the just-developed value theory we can go beyond this. I shall now show that the necessary priorities for deciding the cases can be derived from this theory and the contingent facts.

To start with *Pierson*, we have that Val_{comp} implies $Values(p_2) \succ Values(p_1)$ since p_2 advances *Cval* and p_1 does not advance any value. It then follows from Val_{pr} that $p_2 \succ p_1$, which decides *Pierson*.

Secondly, as for *Keeble*, Val_{comp} implies that $Values(k_1) \succ Values(k_2)$, since the sets to be compared are $\{Eval, Pval\}$ and $\{Cval\}$, and it can be derived that $\{Eval, Pval\} \succ \{Cval\}$. Then Val_{pr} implies that $k_1 \succ k_2$, which decides *Keeble*.

Finally, in *Young* we have that $Values(y_2) \succ Values(y_1)$, since the sets to be compared are $\{Cval, Eval\}$ and $\{Cval\}$ and the first is a proper superset of the second. It then follows from Val_{pr} that $y_2 \succ y_1$, which decides *Young* in the same way as *Pierson*.

4.6. POSSIBLE ADDITIONS AND REFINEMENTS

The value theory could be extended in various ways. For instance, Berman and Hafuer's (1993) notion of a value instrumental to another value could be formalised as follows:

$$Advances(r, V) \Rightarrow Advances(r, V').$$

Or their notion of opposing values could be expressed as follows:

$$\Rightarrow Advances(r, V) \equiv \neg Advances(r, V')$$

(or as a first-order formula without \Rightarrow in \mathcal{F}).

We could also make a difference between not advancing a value and the stronger notion of obstructing it, by adding to \mathcal{F}_n :

$$\forall r, v (Advances(r, v) \Rightarrow \neg Obstructs(r, v)).$$

Then, if we have information that certain rules obstruct certain values, this distinction could be used in a more refined ordering of rules in terms of values, as is done by Hage (2001) in the context of his reason-based logic.

Another refinement concerns explaining the 'backing' of a rule in terms of values. Above, values were only used to induce priorities between conflicting rules. However, sometimes a rule does not conflict with other rules but we still want to say that it is based on a certain value. Consider a precedent that only contains pro-plaintiff factors:

$$r_1 : F \Rightarrow P$$

$$Advances(r_1, V).$$

In a new case we might want to cite this precedent by using r_1 and by saying that this rule should govern the new case since it promotes value V . However, if there is no conflict with another rule, the above method does not allow us to refer to V . To make this possible, the formalisation must be refined.

A natural refinement is to give every rule a ‘backing’ condition (as in Gordon 1995 or Hage 1997), and to include a default in Δ saying that a rule is backed if it advances some value:

$$r_{back} : \exists v \text{Advances}(r, v) \Rightarrow \text{Backed}(r).$$

The above precedent can then be represented as follows:

$$r_1 : F \wedge \text{Backed}(r_1) \Rightarrow P$$

$$r_2 : \text{Advances}(r_1, V).$$

Thus it becomes possible to present a value-based argument in the new case by citing both r_1 and r_2 , jointly with r_{back} .

5. Argument moves in disputes

5.1. GENERAL REMARKS

It is now time to focus on the dialectical interactions between the parties. How does the above framework support value-based argument moves? To start with some general observations, recall that in the 1998 argument game, arguments can be challenged by attacking their conclusion. Now the above value theory provides several types of attacking points, since it talks about whether rules advance values, about the importance of values, about the backing of rules, and about rule priorities. Therefore, our argument game supports arguments and counterarguments on all these issues; no new theory constructors or argument moves need to be defined to make them possible.

In addition, the 1998 system had two theory constructors, viz. analogising a precedent by broadening one of its factor rules, and distinguishing a precedent by attacking the broadened rule on its missing factors. Combined with the present approach this adds some interesting new dialectical interactions to those of the 1998 paper, as will be illustrated below.

As for some preliminaries, plaintiff (as the proponent) starts an argument game with an argument that he wants to show justified. Then at each turn defendant (as the opponent) must defeat plaintiff’s arguments, while plaintiff must strictly defeat defendant’s arguments. For defeat no priorities are needed, but strict defeat requires suitable priorities. Plaintiff can provide them in two ways. The first is to include a priority argument in the strictly defeating argument, while the second way is to state a priority argument that stops defendant’s last move from defeating plaintiff’s previous argument. Both options will be illustrated below.

5.2. ON-POINTNESS VS. VALUES

I first examine a conflict between a value-based and an on-pointness based priority argument. Consider a new case with factors $PLiving$, $\neg OwnLand$, $\neg Caught$ and $\neg DefLiving$. Then *Keeble* and *Young* are not more on point than each other, since *Keeble* shares $PLiving$, $\neg Caught$ and $\neg DefLiving$ with the new case while *Young* shares $PLiving$, $\neg OwnLand$ and $\neg Caught$. Suppose now that the plaintiff starts by citing *Keeble*, broadening k_1 . Plaintiff can say that as in *Keeble*, plaintiff was pursuing his livelihood while defendant was not, so that plaintiff should as in *Keeble* be protected. (Below I again indicate the values advanced by the rules):

$$\pi_1 : k'_1 : PLiving \wedge \neg DefLiving \Rightarrow P \quad (Eval).$$

The defendant can reply by citing *Young* as a counterexample, broadening y_2 . Defendant can say that as in *Young* plaintiff was not on his own land and had not yet caught the animal, so that the case should be decided as *Young*, viz. for the defendant:

$$\delta_1 : y'_2 : \neg OwnLand \wedge \neg Caught \Rightarrow D \quad (Cval).$$

Plaintiff can now reinstate his first argument with a priority argument based on values. He can say that π_1 is better than δ_1 since k'_1 advances *Eval* (economic benefit) while y'_2 advances *Cval* (certainty), and it holds that economic benefit is more important than certainty. (In displaying the argument I suppress some inference steps).

$$\pi_2 : pr_1 : Values(k'_1) \succ Values(y'_2), \text{ so (by } Val_{pr}), k'_1 \succ y'_2.$$

Defendant can counter by saying that *Keeble* is not more on point than *Young*, so that k'_1 does not have priority over y'_2

$$\delta_2 : mop : \neg More-on-point(Keeble, k'_2, Young, y'_1) \Leftrightarrow k'_1 \not\succ y'_2.$$

However, now plaintiff can reply that value considerations override factual comparisons, which makes π_2 stronger than δ_2 .

$$\pi_3 : R_{valmop} : \Rightarrow mop \prec Val_{pr}.$$

It is even possible to construct formal examples where a rule from a less-on-point case is superior on the basis of values. However, it seems that with the above precedents such examples cannot be constructed.

5.3. DOWNPLAYING AND EMPHASISING DISTINCTIONS

Next I turn to distinguishing a precedent. A limitation of the 1998 system was that distinguishing arguments could not be responded to and so finished a line of debate. With the present refinements, however, this is different. Values can be used to argue whether the differences or similarities are more important. This resembles CATO's 'emphasising' and 'downplaying a distinction' moves (although in CATO these moves are not based on value considerations).

Downplaying a distinction

Consider again our new case with *PLiving*, \neg *OwnLand*, \neg *Caught* and \neg *DefLiving*, where plaintiff cited *Keeble* with

$$\pi_1 : k'_1 : PLiving \wedge \neg DefLiving \Rightarrow P \quad (Eval).$$

Defendant has a second option besides citing *Young* as a counterexample: defendant can also distinguish *Keeble* by saying that unlike in *Keeble*, plaintiff was not on his own land, so that the case cannot be decided the same way as *Keeble*:

$$\delta'_1 : d_{k'_1} : \neg OwnLand \Rightarrow D.$$

However, plaintiff can then reply that following *Keeble* advances a value, viz. *Eval* (economic benefit), while distinguishing *Keeble* on *OwnLand* does not advance any value, so that π_1 strictly defeats δ_1 . In other words, plaintiff explains that the difference with *Keeble* is irrelevant:

$$\pi'_2 : pr_2 : Values(k'_1) \succ Values(d_{k'_1}), \text{ so (by } Val_{pr}), k'_1 \succ d_{k'_1}.$$

For a slightly more complex comparison, assume that in addition to *Pierson*, *Keeble* and *Young* we also have a precedent *Evans*, which was decided for plaintiff because plaintiff was pursuing his livelihood and had caught the animal:

Evans:

$$e_1 : PLiving \wedge Caught \wedge \neg DefLiving \Rightarrow P \quad (Eval, Pval)$$

$$e_2 : \neg OwnLand \Rightarrow D.$$

Consider again the new case with *PLiving*, \neg *OwnLand*, \neg *Caught* and \neg *DefLiving*, and assume that plaintiff cites *Evans*, broadening e_1 :

$$\pi_1 : e'_1 : PLiving \wedge \neg DefLiving \Rightarrow P \quad (Eval).$$

Now defendant can distinguish *Evans* with

$$\delta_1 : d_{e_1} : \neg Caught \Rightarrow D \quad (Cval).$$

But now plaintiff can say that the value advanced by e'_1 , viz. *Eval* (economic benefit), is more important than the value advanced by d_{e_1} , which is *Cval* (certainty), so that π_1 prevails over δ_1 . Here plaintiff explains why the similarities with *Evans* are more important than the differences.

Emphasising a distinction

Let us now consider an example in which the differences are more important than the similarities. Consider another new case with $\neg P\text{ILiving}$, $\neg \text{OwnLand}$, *Caught* and *DefLiving*, and assume that in the course of a dispute defendant cites *Young*:

$$\delta_1 : y'_2 : \neg \text{OwnLand} \wedge \text{DefLiving} \Rightarrow D \quad (\text{Eval}).$$

Then plaintiff can distinguish *Young* on *Caught*. Moreover, he can combine this distinction with a priority argument that the value advanced by his rule, viz. *Pval* overrides the value advanced by defendant's rule, which is *Eval*. Thus plaintiff says that the differences with *Young* are more important than the similarities:

$$\pi_2 : d_{y'_2} : \text{Caught} \Rightarrow P, \quad (\text{Pval})$$

$$\text{Values}(d_{y'_2}) \succ \text{Values}(y'_2), \text{ so (by } \text{Val}_{pr}), d_{y'_2} \succ y'_2.$$

5.4. DECIDING YOUNG WITH PIERSON AND KEEBLE

Let us finally examine how in our framework *Pierson* and *Keeble* can be used to argue for defendant in *Young*. Suppose plaintiff in *Young* cites *Keeble* with:

$$\pi_1 : k_1 : P\text{ILiving} \Rightarrow P \quad (\text{Eval}).$$

Then one option for defendant is to distinguish *Keeble* on *OwnLand* and *DefLiving* with

$$\delta_1 : d_{k'_1} : \neg \text{OwnLand} \wedge \text{DefLiving} \Rightarrow D \quad (\text{Eval}).$$

Both arguments are equally strong, since both advance *Eval*, so plaintiff cannot reply with a priority argument.

Another option for defendant is using *Pierson* as a counterexample to *Keeble*:

$$\delta'_1 : p'_2 : \neg \text{OwnLand} \wedge \neg \text{Caught} \Rightarrow D \quad (\text{Cval}).$$

However, this argument is inferior to π_1 , since it only advances *Cval*, which is less important than *Eval*. So plaintiff can reply with the following priority argument.

$$\pi'_2 : pr_3 : \text{Values}(k'_1) \succ \text{Values}(p'_2), \text{ so (by } \text{Val}_{pr}), k'_1 \succ p'_2.$$

Nevertheless, defendant still has a stronger option than distinguishing *Keeble*. Since one *Young* factor missing in *Pierson*, viz. *DefLiving*, favours the defendant, defendant can cite *Pierson* more strongly with the following *a fortiori* argument:

$$\delta_1'' : y_2 : \neg \text{OwnLand} \wedge \neg \text{Caught} \wedge \text{DefLiving} \Rightarrow D \quad (\text{Eval}, \text{Cval}).$$

Now defendant's argument advances *Cval* and *Eval* while plaintiff's argument only advances *Eval*, so defendant has the stronger argument, which means that plaintiff cannot reply with a priority argument. (Strictly speaking, the 1998 framework does not enable such a fortiori arguments, but as we discussed at p. 272, they can be easily added by defining a new theory constructor; see also Sartor 2001.)

At this point plaintiff has run out of moves, since the only attack on δ_1'' is distinguishing *Pierson* on *PLiving*. However, it is easy to see that this argument advances fewer values than δ_1'' , so that plaintiff cannot add the priorities to his argument that are needed for strictly defeating δ_1'' . This in turn means that δ_1'' is justified and π_1 is overruled.

To conclude this section, it should be noted that when implementing the generation of disputes, it is useful to have heuristics for pruning the search space, such as, for instance, 'always cite a most on point precedent' or 'If rules from precedents are available, don't use other rules'. Heuristics of this kind are already part of implemented systems such as HYPO and CATO.

6. Discussion

Bench-Capon (2001) cites Perelman (Perelman and Olbrechts-Tyteca, 1969), who argued that there is more to reasoning than the deductive form of mathematical arguments. Perelman stressed that everyday arguments are not simply valid or invalid, but more or less strong, relevant or convincing. Moreover, Perelman argued that in assessing the relative strength of arguments values play an important role, and he challenged logicians to supplement standard logic with a theory of argumentation that can account for this phenomenon.

Perelman himself has never given an account of how his 'relativistic' view on arguments can be combined with the standard logic 'all or nothing' approach. However, such an account has become possible with the development of nonmonotonic logics, especially those that are argument-based: the 'valid or invalid' view can be applied to the construction of individual arguments, while the 'relative strength' view is reflected in the comparison of conflicting arguments with priority arguments. In the present paper we have seen how such priority arguments can be based on values, as advocated by Perelman.

More specifically, I have made the following contributions to the logical modelling of legal case-based reasoning.

- I have shown how case decisions can be derived from a value theory;
- I have shown how conflicting citations can be compared in terms of their underlying values;

- I have shown how the relevance of distinctions can be debated in terms of values.

Recently, Hage (2001) has made a similar proposal in the context of his earlier developed reason-based logic (Hage, 1997). He fully formalises the notion of obstruction of values mentioned above in Section 4.6 and also shows how *degrees* of support or obstruction of values can be represented. It seems that Hage's representation methods can be directly incorporated in the present approach. Hage does not address the modelling of dialectical moves, such as those of Section 5 above.

To compare the present approach to 'traditional' AI & Law research on case-based reasoning, this paper has used a logical formalism, while, for instance, HYPO and CATO are implemented systems, with limitations on expressiveness. Both approaches have their advantages and disadvantages. One advantage of logic (whether deductive or nonmonotonic) is that it comes with a formal semantics and a precise definition of the logical consequences of a theory. Another advantage of logic is that much can be expressed in a logical language, including unanticipated types of knowledge. The downside of this is that logical formalisms are computationally less tractable than special-purpose languages. Another disadvantage of logic is that purely logical languages do not provide much structure, so that their application involves much work in finding the right way to represent the knowledge.

Berman and Hafner (1993) chose a very structured and specific way to represent purposes. Building on HYPO's way to represent cases, they used a semantic-net-like notation for representing purposes, their interrelations, and their relations with factors and decisions. This gave them the advantages of clear structure and computational efficiency, but their notation lacked a clear semantics, while their reasoning architecture was not fully specified.

In the present paper I have tried to avoid these problems by exploiting the advantages of a logical approach, viz. high expressiveness and a clear definition of what is to be computed. However, I fully realise that implementing my account is not straightforward. For one thing, I have needed the full expressiveness of first-order logic, which is known to be intractable in general. However, even if a full implementation of my account is difficult, it might still serve as a benchmark for more restricted implementations, by providing standards of correctness and completeness. Moreover, the dialectical setting is suitable for applying ideas of resource-bounded computation of e.g. Pollock (1995), Loui (1998) and Vreeswijk (1995).

The above account has one important limitation. As remarked by Bench-Capon (2001) and already briefly mentioned in Section 2, many cases are not decided on the basis of already known values and value orderings, but instead the values and their ordering are *revealed* by the decisions. Thus one of the skills in arguing for a decision in a new case is to provide a convincing explanation for the decisions in the precedents. In terms of my above formalisation, the only information that is always available beforehand is the general theory on how values are included in value sets, and how the ordering of value sets induces an ordering on rule priorities (Val_{comp}).

$f_{valsets}$, r_{noadv} and Val_{pr}). What must often be hypothesised are the value ordering and the statements of the form $Advances(r, v)$. This brings us to the topics of theory formation and inference to the best explanation. In AI (especially diagnosis) and philosophy these are well-studied topics, and in AI & Law Thorne McCarty (e.g. 1995) has emphasised their importance.

Sartor (2001), in his submission to this issue, and Bench-Capon and Sartor (2001) also address the problem of theory formation, in the context of the same class of examples as studied in this paper, viz. value-based comparison of case-based arguments. An important difference with the present approach is that the adversaries do not exchange individual arguments but entire theories. Such theories can be used to construct arguments not just for a desired decision of the current case but also for explaining past cases. Thus it becomes possible to compare proposed decisions for a current case in terms of how well they agree with a given body of case law. Bench-Capon and Sartor also discuss other criteria for evaluating theories. In future research it would be interesting to compare their more 'holistic' approach to the present one and to see to what extent the two can be integrated.

Notes

¹ Below I will use 'values' to cover also purposes, policies, interests etc.

² Bench-Capon (2001) and Sartor (2001) express the presence of negative factors in a case by not including their positive counterparts in the case description.

³ Strictly speaking a rule name is a function expression with as arguments the terms occurring in the rule; thus the proper name of this rule is $r'(r, v)$. For simplicity this complication will be ignored in the rest of this paper.

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