An exercise in formalising teleological case-based reasoning

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Abstract. This paper studies legal case-based reasoning in terms of values instead of factual resemblances. A method is presented for expressing value considerations in the framework of Prakken and Sartor [8] and for using them to explain decisions in precedents, to compare conflicting precedents, and to argue about the relevance of factual differences.

1. Introduction

In their ICAIL-1993 paper, Berman & Hafner [3] presented a challenge for AI & Law research on case-based reasoning. They argued that the then available case-based reasoning systems, especially HYPO [9], were unable to generate 'deep' arguments of the kind lawyers produce, in terms of purposes, policies, interests and values. Giovanni Sartor and myself [8] have tried to capture HYPO-style case-based reasoning in terms of a formal dialogue system for defeasible argumentation. In the present paper I shall present a method for applying this system to teleological case-based reasoning, in an attempt to meet Berman & 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 [8]. 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.

2. The material to be formalised

Berman and Hafner [3] discuss three precedents often presented to American law school students. They concern 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 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.

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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 & Hafner convincingly argue that skilled lawyers do not confine themselves to factual comparisons, but also consider the underlying values.[2] For instance, plaintiff in *Young* could argue that people should be protected when pursuing their livelihood, since society benefits from their activities. Plaintiff could cite *Keeble* as support, arguing that this was the reason why *Keeble* was decided for plaintiff. 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 refers to the value of legal certainty. He can cite *Pierson* as support, by arguing that this was also why *Pierson* was decided for defendant. 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 [3] observe, several interpretations of the cases are possible. Below I shall formalise one particular interpretation, which largely follows the one of Bench-Capon [2]. I give this interpretation in schematic way.

The relevant factors

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

As for the tendency of factors, *PlLiving*, *OwnLand* and *Caught* are pro-plaintiff factors, *DefLiving* is a pro-defendant factor, and the opposite of a pro-party factor favours the other party (for instance, ¬*PlLiving* is a pro-defendant factor).

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 (decided for defendant):

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

[2] Below I will use ‘values’ to cover also purposes, policies, interests etc.

Keeble (decided for plaintiff):

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

Young (decided for defendant):

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

Values:
I assume that the following values are at stake (listed in descending order of importance):

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

How case decisions advance values

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

- Deciding for plaintiff because of *PlLiving* advances *Eval*.
- Deciding for plaintiff because of *OwnLand* advances *Pval*.
- Deciding for plaintiff because of *Caught* advances *Pval*.
- Deciding for defendant because of ¬ *Caught* advances *Cval*.
- Deciding for defendant because of *DefLiving* advances Eval.

When there are more factors, this can simply be combined. For instance, deciding for plaintiff because of *PlLiving* and *OwnLand* advances the values *Eval* and *Pval*.
Actually, in many cases it will be debatable whether a certain decision advances a certain value (and also which values are more important). This paper's framework supports debates on such issues, but for simplicity I assume that they do not arise.

3. The formalism

The formalism to be used is that of Prakken and Sartor [8]. It consists of a logic for defeasible argumentation, a way of representing precedents, a 'dynamic' argument game that allows for the introduction of new information into a dispute, and two 'theory constructors' for doing so by analogising or distinguishing predecents.

3.1 The logic

The 1998 system builds on the argumentation logic of Prakken and Sartor [7] , which has the language of extended logic programming. However, in the present paper I shall use the extra expressive power of the version of Prakken [6] , which extends the language to that of default logic.

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 facts are beyond debate; only defeasible rules can make an argument subject to

defeat. Defeasible rules as used in this paper are of the form r: $A \Rightarrow C$ where A and C are first-order formulas. Each rule is prefixed with a term, its name.

Arguments are chains of defeasible rules 'glued' together by first-order inferences. Arguments 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. Two arguments can defeat each other, viz. when a rule conflict is not resolved by the given rule priorities. If one argument defeats the other but not vice versa, 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 arguments as 'justified', 'overruled' or 'defensible'. It is defined in the form of an argument game, where the proponent starts with an argument to be proven justified, and then both players attack each other's arguments. An argument is *justified* if the proponent has a winning strategy, i.e., if he can make the opponent run out of moves in whatever way she plays; an argument is *overruled* if it is defeated by a justified argument, and it is *defensible* otherwise.

3.2 A method for representing cases

The 1998 paper also proposed a way to represent precedents. 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 conflicting factor-decision rules and an unconditional priority rule resolving their conflict.

r_1: *Pro-factors* $\Rightarrow$ *Decision*
r_2: *Con-factors* $\Rightarrow \neg$ *Decision*
p: $\Rightarrow r_1 \succ r_2$

However, we remarked that the priority $r_1 \succ r_2$ could very well be established in a competition between arguments. This is what 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 was captured by the possibility to broaden a case rule by deleting the antecedents missing in the new case, and distinguishing was captured by the possibility to introduce a conflicting rule 'if these factors are absent, 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. 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.

4.1 The formalisation methodology

Following Sartor [10] and in line with Hage [4], I will link case decisions to values with expressions 'deciding case c with decision d because of factor f advances value v'. Formally, if the decision rule is r: $f \Rightarrow d$, I write $Advances(r,v)$. Here I exploit the fact that our language contains rule names as terms and thus allows the expression of information *about* rules. I then use the information on the value(s) advanced by a rule to state priorities between rules: the more important the set of values advanced by a rule, the higher its priority.

4.2 The 'hard' facts and rules

The necessary facts $\mathcal{F}_n$ include 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 $\mathcal{F}_c$ contain the facts of a current case, and state which values are advanced by which rules. $\mathcal{F}_c$ also contains an ordering of the three values:

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

4.3 The defeasible information

Since value considerations might be overridden by other grounds, such as a court's authority or a decision's recency, 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.
I first add a rule Val_{comp} that orders sets of values in terms of an ordering on their elements. In words, it 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 $Values_2$.

Val_{comp}:
$\forall values_1, values_2\ [\forall v_2\ ((In(v_2, values_2) \wedge \neg\ In(v_2, values_1)) \Rightarrow$
$\exists v_1\ (In(v_1, values_1) \wedge \neg\ In(v_1, values_2) \wedge v_1 \succ v_2))$
$\Leftrightarrow values_1 \succ values_2]$

($A \Leftrightarrow B$ 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.
Individual value sets will be denoted by terms $Values(r)$, standing for the values advanced by rule r. A value becomes included in a rule's value set if it can be derived that the rule advances the value. So we must also have the following definition in $\mathcal{F}_n$.

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

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, I 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.

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

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

4.4 The cases

As for the cases, I list the factor and priority rules, and also the values that 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:
$p_1: \neg DefLiving \Rightarrow P$
$p_2: \neg PlLiving \wedge \neg OwnLand \wedge \neg Caught \Rightarrow D$ (*Cval*)
$pr_1: \Rightarrow p_2 \succ p_1$

Keeble:
$k_1: PlLiving \wedge OwnLand \wedge \neg DefLiving \Rightarrow P$ (*Eval,Pval*)
$k_2: \neg Caught \Rightarrow D$ (*Cval*)
$pr_2: \Rightarrow k_1 \succ k_2$

Young:
$y_1: PlLiving \Rightarrow P$ (*Eval*)
$y_2: \neg OwnLand \wedge \neg Caught \wedge DefLiving \Rightarrow D$ (*Cval, Eval*)
$pr_3: \Rightarrow y_2 \succ y_1$

4.5 Deriving the case decisions from the value theory

I shall now show that the necessary priorities for deciding the cases can be derived from our value 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 $\{Eval,Pval\} \succ \{Cval\}$. 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*.

5. Argument moves in disputes

Let us now focus on the dialectical interactions between the parties. How does the above framework support value-based argument moves? The system of Prakken and Sartor [8] 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 enables some interesting new dialectical interactions.

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.

Evaluating a counterexample

First I show how the strength of a counterexample can be assessed in terms of values. Consider a new case with factors *PlLiving*, ¬*OwnLand*, ¬*Caught* and ¬*DefLiving*. Suppose 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.

π_1: k_1': $PlLiving \wedge \neg DefLiving \Rightarrow P$ (*Eval*)

Defendant now has two ways to attack this argument. The first is to cite *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:

δ_1: y_2': $\neg OwnLand \wedge \neg Caught \Rightarrow D$ (*Cval*)

Keeble and *Young* are not more on point than each other, since *Keeble* shares *PlLiving*, ¬*Caught* and ¬*DefLiving* with the new case while *Young* shares *PlLiving*, ¬*OwnLand* and ¬*Caught*; so HYPO would not prefer one precedent over the other. However, with our value theory plaintiff can reinstate his first argument by saying that π_1 is better than δ_1 since k_1' advances economic benefit while y_2' advances certainty, and economic benefit is more important than certainty. (I display only part of the argument).

π_2: pr_1: $Values(k_1') \succ Values(y_2')$, *so* (*by* Val_{pr}), $k_1' \succ y_2'$

Downplaying a distinction

Next I turn to distinguishing a precedent. A limitation of the 1998 account was that distinguishing arguments could not be responded to and so finished a line of debate. Now, however, values can be used to argue about the importance of differences. This resembles CATO's [1] 'emphasising' and 'downplaying a distinction' moves (although in CATO these moves are not based on value considerations).

I first illustrate downplaying. Consider again our new case with *PlLiving*, ¬*OwnLand*, ¬*Caught* and ¬*DefLiving*, where plaintiff cited *Keeble* with π_1. Defendant's second possible reply is to 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*:

$$\delta_1' : dk_1' : \neg\, OwnLand \Rightarrow D$$

However, plaintiff can reply that following *Keeble* advances economic benefit, while distinguishing *Keeble* on *OwnLand* does not advance any value, so that π_1 strictly defeats δ_1. Thus plaintiff argues that the difference with *Keeble* is irrelevant:

$$\pi_2' : pr_2 : Values(k_1') \succ Values(dk_1'),\ so\ (by\ Val_{pr}),\ k_1' \succ dk_1'$$

Emphasising a distinction Consider, finally, an example in which the differences are more important than the similarities. Consider another new case with ¬*PlLiving*, ¬*OwnLand*, *Caught* and *DefLiving*, and assume that in the course of a dispute defendant cites *Young*:

$$\delta_1 :\ y_2' : \neg\ OwnLand \wedge DefLiving \Rightarrow D \qquad (Eval)$$

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:

$$\pi_2 :\quad dy_2' : Caught \Rightarrow P, \qquad (Pval)$$
$$Values(dy_2') \succ Values(y_2'),\ so\ (by\ Val_{pr}),\ (dy_2') \succ y_2'$$

6. Discussion

In the present paper I have presented a method for representing and reasoning with value considerations in case-based legal argument. More specifically, I have made the following contributions. Firstly, I have shown how case decisions can be derived from a value theory and information on the importance and advancement of values. Secondly, I have shown how conflicting citations can be compared in terms of their underlying values. And, finally, I have shown how the relevance of distinctions can be debated in terms of values.

In this paper I have confined myself to presenting the core elements of the method. It seems a straightforward logical exercise to refine the method with, for instance, degrees of value advancement, value detraction, and relations of instrumentality or opposition between values.

The present account has one important limitation. As Bench-Capon [2] observes, 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 topic of theory formation (cf. e.g. [5]). In the

present setting, I see two ways to include ‘explanation generators’. They could be defined as new theory constructors (which leaves the logic intact) or they could be captured with a new type of arguments, viz. explanations (which requires a change in the logic). However, neither of these two suggestions are trivial, for which reason I leave them for future research.

References

[1] Aleven, V. and K.D. Ashley. Evaluating a learning environment for case-based argumentation skills. In Proceedings of the sixth International Conference on Artificial Intelligence and Law, pages 170-179, New York, 1997. ACM Press.

[2] Bench-Capon, T.J.M. The missing link revisited: the role of teleology in representing legal argument. Artificial Intelligence and Law, 2000. Submitted.

[3] Berman, D.H. and C.D. Hafner. Representing teleological structure in case-based legal reasoning: the missing link. In Proceedings of the Fourth International Conference on Artificial Intelligence and Law, pages 50-59, New York, 1993. ACM Press.

[4] Hage, J.C. Reasoning with Rules. An Essay on Legal Reasoning and Its Underlying Logic. Law and Philosophy Library. Kluwer Academic Publishers, Dordrecht/Boston/London, 1997.

[5] McCarty, L.T. An implementation of Eisner v. Macomber. In Proceedings of the Fifth International Conference on Artificial Intelligence and Law, pages 276-286, New York, 1995, ACM Press.

[6] Prakken, H. Logical Tools for Modelling Legal Argument. A Study of Defeasible Argumentation in Law. Law and Philosophy Library. Kluwer Academic Publishers, Dordrecht/Boston/London, 1997.

[7] Prakken, H. and G. Sartor. Argument-based extended logic programming with defeasible priorities. Journal of Applied Non-classical Logics, 7:25-75, 1997.

[8] Prakken, H. and G. Sartor. Modelling reasoning with precedents in a formal dialogue game. Artificial Intelligence and Law, 6:231-287, 1998.

[9] Rissland, E.L. and K.D. Ashley. A case-based system for trade secrets law. In Proceedings of the First International Conference on Artificial Intelligence and Law, pages 60-66, New York, 1987. ACM Press.

[10] Sartor, G. Teleological arguments and theory-based dialectics. Artificial Intelligence and Law, 2000. Submitted.