Reasoning with Precedents in a Dialogue Game

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Abstract

This paper analyzes legal reasoning with precedents in the setting of a formally defined dialogue game. We first propose a formal method for representing precedents that generalises and refines earlier factor-based proposals in AI & Law. Then we discuss how such representations can be used in a formally defined dialectical protocol for dispute. The main idea is to define the analogizing and distinguishing of precedents as strategies for introducing new information into a dispute. The approach of this paper has a number of advantages, such as an increased expressiveness of the language, the ability to use portions of precedents and the possibility to evaluate the outcome of disputes. Moreover, our approach has a foundation in argument-based semantics of defeasible reasoning.

1 Introduction

This paper attempts to build a bridge between AI & Law research on case-based reasoning and recent more logic-oriented AI & Law research on defeasible argumentation. In particular, we aim to show how analogical reasoning with precedents can be modelled within the dialogue game for reasoning with conflicting arguments that we developed in [Prakken & Sartor, 1996b, Prakken & Sartor, 1997a]. Thus we hope to show how logical work on defeasible argumentation relates to case-based features of legal argument, so far considered to fall outside the province of logic.

In AI & Law research on precedent-based reasoning factor-based models have been very popular. In such models every precedent case is represented as a set of factors, which push the case towards (pro) or against (con) a certain decision, plus a decision which resolves of the conflict between the competing factors; new cases are expected to be resolved in accordance with decisions performed in the past. HYPO [Ashley, 1990], in particular, produces arguments which cite cases in favour of the pro and con sides, those cases being selected according to their utility to support the position of each side. We now briefly outline the main features of HYPO, as far as relevant for our discussion.

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Case-based reasoning in HYPO

HYPO (and its successor CATO, e.g. [Aleven & Ashley, 1996]) aims to model how lawyers make use of past decisions in disputes with their opponents. The system generates 3-ply (CATO: 4-ply) disputes between a proponent ('plaintiff') and an opponent ('defendant') of a legal claim, where each move conforms to certain rules for analogizing and distinguishing legal precedents. These rules determine for each side which are the best cases to cite initially, or in response to the opponent's move, and how the opponent's cases can be distinguished. A best case for a side is a case that shares with the Current Fact Situation (CFS) at least one factor which favours the side for which it is cited, and shares a most inclusive set of factors with the CFS, in comparison with other cases confirming the desired decision (on pointness).

A citation can be countered by a counterexample, that is a case that is at least as much on point, but has the opposite outcome. A citation may also be countered by distinguishing, that is by indicating a factor in the CFS which is absent in the cited precedent and which supports the opposite outcome, or a factor in the precedent which is missing in the CFS, and which supports the outcome of the cited case.

In choosing an appropriate argument move, a crucial aspect is the tendency of facts towards or against a decision. Consider the following example, where the issue is whether a stay in another country changes one's fiscal domicile with respect to income tax. Assume that we can identify the following factors pro and con.

- Pro change is that the old house was given up, while con change is that it was kept.
- Pro change is that the tax payer's employer is based in the new country, while con change is that the employer is based in the old country.
- Pro change is that the duration of the stay is long, while con change is that the duration is short.[1]

Now suppose we have the following three precedents, where the pro decision factors are given in italics and the con decision factors in normal type face (note that we do not assume that each factor receives a definite value in each case: the duration may be neither long nor short, so that it does not push the decision in any direction).

[1]For simplicity we will in this paper assume, unlike HYPO, that all factors are twovalued, i.e. either true or false.

A:	Factors:	*long duration*, *gave up house*, domestic employer
	Decision:	change
B:	Factors:	*foreign employer*, kept house
	Decision:	change
C:	Factors:	*gave up house*, short duration, domestic employer
	Decision	no change

Assume that the facts of a new case (the CFS) are:

long duration, domestic employer, kept house

All precedents share some factors with the new case:

A ∩ CFS = {*long duration*, domestic employer}
B ∩ CFS = {kept house}
C ∩ CFS = {domestic employer}

Suppose that Side 1 in the new case wants to argue that also in the CFS the fiscal domicile has changed. Although both A and B have this outcome, B is not citable for Side 1, since the only factor it shares with the common situation is against change. Only A can be cited by Side1. Side 2 can only answer to the citation of A by distinguishing, that is by referring to the factor 'kept house', which is a no change factor in the CFS not shared by A.

In evaluating the relative force of the moves HYPO uses the set inclusion ordering on the factors that the precedents share with the CFS. For instance, if in the above CFS a party cites C in defence of the claim 'no change', then the other party can distinguish C with respect to the factor '*long duration*', by drawing an analogy with the 'trumping counterexample' A. The citation of A is regarded as better ('more on point') than that of C, since the factors that A shares with the CFS include those that C shares with the CFS.

Note that HYPO's reasoning forms (citing cases, citing counterexamples, distinguishing) are not only based on the set inclusion ordering on the shared factors with the CFS, but also on the tendency of the factors toward a certain outcome. A case is citable for a side only if this case shares with the CFS a factor favouring that side, and a case with a factor missing in the CFS can be distinguished only if the missing factor is against the outcome of distinguished case. Therefore, in representing precedents it is essential that this tendency of factors is somehow represented. HYPO does so by simply marking them Pro or Con the decision. In this paper we will propose an alternative method.

The need for extending HYPO

HYPO's model is quite attractive, since it emphasizes the dialectical nature of legal reasoning while reducing it to a limited set of argument moves, based on a simple knowledge representation scheme. However, it has frequently been observed that HYPO's way of representing cases is still too coarse, since it has no way of representing how facts contribute to a decision. Cases are essentially represented as a collection of factors, and a decision; no intermediate reasoning steps from factors to decision can be represented. Therefore HYPO does not do justice to the typical stepwise construction of legal arguments, in which subordinate questions need to be answered in order to obtain the final outcome of the case. For instance, the factors in the above example might result from more basic factors: whether the house is kept or given up might depend on whether it is sold, or rented for a long period, and whether the employer is foreign might depend on whether the employer has a foreign nationality, or owns a separate production or administration unit in the country where the worker is supposed to go, and so on. Although in [Aleven & Ashley, 1996] the HYPO/CATO architecture is extended with a 'factor hierarchy', which allows the expression of relations between factors of different levels of abstraction, this hierarchy is regarded as undebatable common knowledge of the arguers; the case representations can still not express the intermediate decisions of a precedent.

Branting [1994] has proposed a way to overcome this limitation of HYPO. He essentially represents the ratio decidendi of precedents as a logical argument, i.e. as a logically valid sequence of reasoning steps starting from a set of premises. Moreover, he allows the citation of parts ("portions") of the ratio decidendi, and he allows analogical reasoning with respect to all intermediate conclusions. However, although thus Branting's model overcomes a limitation of HYPO, it gives up one fundamental aspect of HYPO's approach, its dialectical nature. Note that this character not only concerns the last reasoning step, but every previous passage. For example, in relation to the domestic nationality of the employer, the fact that he has national citizenship is pro, while the fact that he has foreign headquarters is con, in relation to the keeping of the house, the factor house-sold is against, house-long-term-rented is con, while house-short-term-rented is pro, house-empty is pro, and so on.

Our proposal: the basic idea

In this paper we make a proposal that (we think) preserves the strong points of both HYPO/CATO and Branting's model, but overcomes their limitations. Our idea has two elements. Firstly, we propose, inspired by [Loui & Norman, 1995], to represent precedents not just as one logical argument but as a set of possibly conflicting arguments, including arguments on the comparative evaluation of other arguments. Those 'priority' arguments will make it possible to express why certain factors were outweighed by other factors. This method does justice to both HYPO/CATO's and Branting's models: each precedential argument may include multiple steps (as Branting suggests), but the conclusion derived in each of those steps may be the matter of a dispute in which factors pro and con that conclusion are resolved (as HYPO/CATO would do).

Secondly, in order to capture the dialectical nature of the HYPO/CATO approach, we will embed our representation method in the formal dialogue game developed in [Prakken & Sartor, 1996b, Prakken & Sartor, 1997a]. In particular, we will model HYPO-style analogizing and distinguishing as strategies for introducing new premises into a dialogue.

2 Logical preliminaries

The logical background assumed in this paper is the argument-based system of [Prakken & Sartor, 1996a, Prakken & Sartor, 1996b, Prakken & Sartor, 1997a] (although other systems with similar features will do as well). In this section we briefly describe the basic elements of the system. The logical language is that of extended logic programming. i.e.

it has both negation as failure ($\sim$) and strong negation ($\neg$). We add to this language one feature: each formula is preceded by a term, its name. Rules can be *strict*, represented with $\rightarrow$, or else *defeasible*, represented with $\Rightarrow$. The idea is that strict rules are beyond debate; only defeasible rules can make an argument subject to defeat. Facts can thus be represented as strict rules with empty antecedents (e.g. $\rightarrow$ *gave-up-house*). The input information of the system, which we call an *ordered theory*, is a set of strict and defeasible rules.

Arguments can be formed by chaining rules, ignoring weakly negated antecedents; each head of a rule in the argument is one of its conclusions. Conflicts between arguments are (partly) decided by utilising priorities that are defined on the rules, and which induce a binary relation of *defeat* among arguments. An important feature of our system is that the information about these priorities is itself presented as premises in the logical language, as in

r: r_1 *is decided by higher court than* $r_2 \Rightarrow r_1 \prec r_2$

(Here $r_1 \prec r_2$ means that r_2 is preferred over r_1). Thus debates about priorities can be formalized in the same way as debates about any other matter.

The relation of *defeat* is intended to be a weak notion: intuitively 'Arg_1 defeats Arg_2' means that Arg_1 and Arg_2 are in conflict and that Arg_1 is not worse than Arg_2. This means that two arguments can defeat each other. If Arg_1 is, moreover, better than Arg_2, this implies that Arg_2 does not defeat Arg_1. Then we say that Arg_1 *strictly defeats* Ag_2.

There are two ways in which an argument Arg_1 can defeat an argument Arg_2. The first is *undercutting* it, which occurs if a rule in Arg_1 weakly negates L in its body (as $\sim L$) while Arg_2 has a conclusion L. For instance, the argument $[r_1\colon \rightarrow p,\ p \Rightarrow q]$ (strictly) defeats the argument $[\sim q \Rightarrow r]$. The other way, rebutting an argument, is only possible if Arg_1 does not undercut Arg_2: then Arg_2 defeats Arg_1 if and only if these arguments contain rules that are in a head-to-head conflict and where Arg_2's rule is not worse than the conflicting rule in Arg_1. For instance, the arguments[2]

[f_1: *short-duration*,
r_1: *short-duration* $\Rightarrow$ *change-fiscal-domicile*]
[f_2: *foreign-employer*,
r_2: *foreign-employer* $\Rightarrow \neg$ *change-fiscal-domicile*]

defeat each other if they are of equal priority or if no priorities hold between r_1 and r_2, while the first strictly defeats the second if r_1 has priority over r_2.

The defeat relation is not yet the final assessment of arguments: since it is just a comparison between two individual arguments, it does not capture the phenomenon of 'reinstatement'. To illustrate this notion, assume that an argument A is strictly defeated by an argument B, which in turn is strictly defeated by an (undefeated) argument C; then intuitively C reinstates A. This is captured by the final element of our system, which, taking all interactions between the possible arguments into account, divides these arguments into three classes: the *justified* arguments, those with which a dispute can be 'won', the *overruled* arguments, with which a dispute should be 'lost', and the *defensible* arguments, which should leave the dispute undecided. The proof-theoretical version of his definition has the form of a dialogue game, and will be discussed below in Section 4.

[2] For notational convenience we will often list a fact of a case as a literal preceded by a name f_i. Formally, a fact p_i with name f_i is a strict rule $f_i\colon \rightarrow p_i$.

3 A method for representing cases

Our method for representing legal precedents has two components: representing the tendency of a factor in a logical rule, and representing a precedent with conflicting factors as a set of conflicting logical arguments. As for the tendency of factors, this will be represented as follows. A rule 'f is a reason pro d' is represented as a rule r: $f \Rightarrow d$. And if a case contains more than one factor favouring a certain decision, this will be represented as a rule with a conjoined antecedent, e.g. r: $f_1 \wedge f_2 \Rightarrow d$.

As for representing precedents, above we said that we will represent them as collections of, possibly conflicting, arguments. In fact we will present them in a slightly simpler way, viz. as sets of rules from which the arguments pro and con can be constructed. The precise method is as follows. Since we want to read a rule *antecedent* $\Rightarrow$ *consequent* as saying that the antecedent is a reason for the consequent, we cannot express a dominance of, say, the pro factors over the con factors by conjoining pro and con reasons in the antecedent of a rule with the pro consequent. Instead we will express the tendency of opposing factors as two conflicting rules and add one or more rules on their comparative evaluation.

For example, let us assume that a short duration of the working stay outweighs the fact that the employer is foreign; we do not express that by a combined rule

r: *Short-duration* $\wedge$ *foreign-employer* $\Rightarrow$
$\neg$ *change-fiscal-domicile*

Instead, we will represent this as

r_1: *short-duration* $\Rightarrow \neg$ *change-fiscal-domicile*
r_2: *foreign-employer* $\Rightarrow$ *change-fiscal-domicile*
r_3: *antecedent* $\Rightarrow r_2 \prec r_1$

Here *antecedent* expresses the conditions under which *short-duration* outweighs *foreign-employer* (as far as a change is fiscal domicile is concerned.) In realistic examples *antecedent* will itself often be derived (dialectically!) from other rules. In fact, one major advantage of this representation scheme is that it makes it possible to express the grounds why certain factors override certain other factors, in the form of antecedents of priority rules. However, in this paper we will for simplicity mainly use priority rules with empty antecedents.

As usual in legal theory, we assume that precedents contain general rules, i.e. that they contain variables instead of ground terms (except for the priority rule of a case). Furthermore, we will leave the case facts implicit in our notation: if the antecedent of some case rule is not provided by another rule of the same case, then the antecedent is implicitly included in the case as a strict rule f: $\rightarrow$ *antecedent*.

4 The dialectical context

Just defining a representation method in a logical language is not enough; we must also specify the dialectical context in which the represented information can be used. This will be done in this and the following section. Our idea is to embed the method in the dialectical proof theory that we developed in [Prakken & Sartor, 1996b, Prakken & Sartor, 1997a] for our argumentation framework. For the technical details and related work of others the reader is referred to these papers. The proof theory has the form of a dialogue game. Its idea is that a proof of a formula takes the form of a dialogue tree, where each branch of the tree is a dialogue, and the root of the tree is an argument for the formula. Every move in a dialogue consists of an argument based on the premises. The essence of the dialogue game is that each stated argument attacks the last move of the opponent in a way that meets the player's burden of proof. The required force of a move depends on who states it. Since the proponent wants a conclusion to be justified, a proponent's move has to be strictly defeating, while since the opponent only wants to prevent the conclusion from being justified, an opponent's move may be just defeating. A subtlety here is that for determining the force of the proponent's move only the priorities stated by that move count, while for assessing the opponent's move no priorities need to be applied at all.

In [Prakken & Sartor, 1997a] we prove that this proof theory is sound and under certain finiteness conditions also complete with respect to the fixpoint semantics defined in [Prakken & Sartor, 1996a]. Since this semantics is a special case of more general research of [Dung, 1995], this means that our dialogue game has a well-understood logical foundation.

The dialogue game is defined relative to an arbitrary but fixed ordered theory. In [Prakken & Sartor, 1996b] we remarked that although thus the parties in a dispute are restricted to using rules from a given 'pool' of premises, this is just a theoretical restriction; we said that the definitions also apply if it is assumed that the pool of premises consists of everything put forward by the parties in a dialogue. The idea of this section is to make this more precise. More specifically, we want to regard HYPO-style reasoning with precedents as a protocol for introducing information into a dispute.

Let us first repeat the central definition of the dialogue game ('*Arg*-defeat' means defeat on the basis of the priorities stated by *Arg*).

Definition 4.1 *A* dialogue *is a finite nonempty sequence of moves* $move_i = (Player_i, Arg_i)$ $(i > 0)$, *such that*

1. $Player_i = P$ *iff i is odd; and* $Player_i = O$ *iff i is even;*
2. *If* $Player_i = Player_j = P$ *and* $i \neq j$, *then* $Arg_i \neq Arg_j$;
3. *If* $Player_i = P$ *then*
   - Arg_i *strictly* Arg_i*-defeats* Arg_{i-1}; *or*
   - Arg_{i-1} *does not* Arg_i*-defeat* A_{i-2};
4. *If* $Player_i = O$ *then* Arg_i $\emptyset$*-defeats* Arg_{i-1}.

A dialogue is based on a set of rules Γ *iff all rules of* Arg_i *are in* Γ.

The first condition says that the proponent begins and then the players take turns, while the second condition prevents the proponent from repeating its attacks. The last two conditions form the heart of the definition: they state the burdens of proof for P and O. Condition (3) gives P two types of moves: the first is an argument that combines an attack on O's move with a priority argument that makes the attack succeed; the second just consists of a priority argument, neutralizing the defeating force of O's last move. Finally, condition (4) says that O does not have to take priorities into account.

The following simple dialogue illustrates this definition (the rule names refer ahead to the representation below of precedent B).

P_1:	$[f_1$:	*kept-house*,
	r_1:	*kept-house* $\Rightarrow \neg$ *change*]
O_1:	$[f_{10}$:	$\neg$ *domestic-headquarters*,
	r_{10}:	$\neg$ *domestic-headquarters* $\Rightarrow$ $\neg$ *domestic-company*,
	r_4:	$\neg$ *domestic-company* $\Rightarrow$ *change*]
P_2:	$[f_7$:	*domestic-property*,
	r_7:	*domestic-property* $\Rightarrow$ *domestic-company*,
	f_{14}:	r_7 *is decided by higher court than* r_{10},
	p:	r_7 *is decided by higher court than* $r_{10} \Rightarrow r_{10} \prec r_7$]

P starts the dialogue with an argument for '$\neg$ change', after which O_1 attacks this argument with an argument for the opposite conclusion. O_1 has the required defeating force, since in our logical system two rebutting arguments defeat each other if no priorities apply to the conflict. P_2 illustrates the first possible reply of P to O's moves: it combines a 'normal' argument with a priority argument that makes it strictly defeat O's move. The second possibility, just stating a priority argument that neutralizes the defeating force of O's move, is illustrated by the following alternative move:

P_2':	$[f_{15}$:	r_1 *is more recent than* r_4,
	p':	r_1 *is more recent than* $r_4 \Rightarrow r_4 \prec r_1$]

Next we give the definition of a 'dialogue tree'.

Definition 4.2 *A* dialogue tree *based on an ordered theory* Γ *is a tree of moves such that*

1. *Each branch is a dialogue based on* Γ;
2. *If* $Player_i = P$ *then the children of* $move_i$ *are all defeaters of* Arg_i *based on* Γ.

The second condition of this definition makes dialogue trees candidates for being proofs: it says that the tree should consider all possible ways in which O can defeat a move of P. This is why the definition is relative to an ordered theory. (Note that the definition further allows that P-nodes have several children). The above example has (assuming there are not more premises) a dialogue tree of two dialogues, $P_1 - O_1 - P_2$ and $P_1 - O_1 - P_2'$.

The final definition defines the outcome of a dialogue game.

Definition 4.3 *A player* wins a dialogue *based on* Γ *iff the other player cannot move. A player* wins a dialogue tree *based on* Γ *iff he wins all its branches. An argument A is* justified *on the basis of* Γ *iff there exists a dialogue tree based on* Γ *with A as root and won by P. And, based on* Γ, *an argument is* overruled *iff it is defeated by a justified argument, and* defensible *iff it is neither justified nor overruled. Finally, a claim C is a* justified conclusion *on the basis of* Γ *iff there is a justified argument for C based on* Γ.

5 A protocol for reasoning with precedents

We now describe how HYPO-style reasoning can be regarded as a theory (protocol) on how to enter information into a dispute. We will discuss four things: the background information from which premises can be constructed, reasoning with precedents, and conducting and evaluating actual disputes.

5.1 The background information

We will describe the protocol relative to a background theory of precedents, facts and eventual other information. A precedent is defined as follows.

Definition 5.1 *(precedents) A* precedent Case *is a pair* (CaseFacts,CaseRules)*, where*

- CaseFacts *is a set of strict rules;*
- CaseRules *is a set of rules.*

If Cases *is a set of precedents, then* Rules-of-Cases *is the union of the sets* CaseRules *of all precedents in* Cases*.*

Recall that in our model a precedent can be conceived in two ways, as consisting of premises (facts and rules), or as consisting of arguments. The arguments in a precedent *Case = (CaseFacts, CaseRules)* are exactly all those which can be built from the ordered theory *(CaseFacts, CaseRules)*. This means that those arguments can with Definition 4.3 be classified as justified, defensible, or overruled on the basis of $\Gamma = Case$. This is relevant for the theory of precedent, since it allows us to define a notion of ratio decidendi of a case as any justified argument on the basis of that case.

Let us now define the 'background information' of the protocol. This should not be confused with the ordered theory of our logical system: the background information is the information from which the ordered theory can be (dialectically) constructed by the parties. It consists of a set of precedents, a set of 'common-sense' rules, which might, for instance, include the applicable law, and a set of strict rules, representing the current fact situation.

Definition 5.2 *(Background Information) A* Background Information theory (BI) *is a triple* (Cases,CFS,CSRules)*, where*

- Cases *is a set of precedents;*
- CFS *is a set of strict rules, the current fact situation;*
- CSRules *is a set of rules, the 'common sense' knowledge.*

5.2 Reasoning with precedents

How can the background information be used to introduce information into a debate? As a first approximation the idea is that each move of the players should consist of only rules from *Rules-of-Cases* $\cup$ *CFS* $\cup$ *CSRules* (obviously, the facts of a precedent may in a new fact situation not be used). However, to capture HYPO-style reasoning, we must also allow for the introduction of rules that are not contained in any of these sets but that can be obtained by analogizing or distinguishing a precedent.

First we define how these kinds of reasoning result in new rules. Informally, the idea is that a rule can be broadened by omitting one or more of its antecedents, while a broadened rule can be distinguished by a rule that says that the omitted antecedents were necessary to warrant the consequent, that without them the consequent does not hold.

To formalize this we have to define a naming convention for rules, in order to encode which rule broadens which. As for the rule names of the case rules, we will assume that these consist of function expressions of the form $name(t, t_1, \ldots, t_n)$, where $name$ is as usual the informal name of the rule, and where $t_1, \ldots, t_n$ are as usual the terms occurring in the rule. What t stands for depends on whether the rule is intended to be a broadening of another rule or not. If not, then t = '$name$'; otherwise t is equal to the name of the rule of which $name$ is intended to be a broadening.

Below we will also use the following notation: for any rule r the set of literals occurring in its antecedent is denoted by $Antlits(r)$, while its antecedent and consequent are denoted by $ANT(r)$ and $CONS(r)$).

Definition 5.3 *A rule r*

- broadens *a rule r' iff the first argument of r's name is r', if they have the same consequent and if $Antlits(r) \subseteq Antlits(r')$.*
- distinguishes *a rule r' iff*
  1. *r and r' have contradictory consequents; and*
  2. *r' broadens a rule r'' in* Rules-of-Cases *such that there are literals $L_1, \ldots L_n$ such that*
     (a) *$L_1, \ldots L_n$ are included in $ANT(r'')$ but not in $ANT(r')$;*
     (b) *$ANT(r) = \sim L_1 \wedge \ldots \wedge \sim L_n (n > 0)$.*

The condition that the first argument of r's name is r' is needed to deal with situations where a certain rule r contained in one precedent C_1 is also syntactically a broadening of a rule in another precedent C_2. If we directly use the rule as contained in C_1, the first argument of r's name is r, and if we use r as broadening a rule r' in C_2, the first argument of its name is r'. Only in the second case can r be distinguished. From now on we will leave this naming method implicit.

We illustrate the definition with a rule

$r_{2/4/6}$: $\neg$ *kept-house* $\wedge$ $\neg$ *domestic-company* $\wedge$ *long-duration* $\Rightarrow$ *change*

Of the following two rules, $r_{4/6}$ broadens $r_{2/4/6}$ while r_2 distinguishes $r_{4/6}$.

$r_{4/6}$: $\neg$ *domestic-company* $\wedge$ *long-duration* $\Rightarrow$ *change*
r_2: $\sim \neg$ *kept-house* $\Rightarrow \neg$ *change*

Our definition of distinguishing only covers cases where the *CFS* misses some factors of the precedent; the form of distinguishing that emphasises a new factor not present in the precedent can be modelled by adding knowledge about the tendency of factors to *CSRules* in the form of rules r: *factor* $\Rightarrow$ *supported conclusion*.

5.3 Actual disputes

Our dialogue game of Section 4 serves as a (dialectical) proof theory, and therefore it assumes a fixed set of premises. In the present section, however, we are concerned with actual disputes, i.e. disputes in which the set of premises is constructed dynamically, during the dispute. Accordingly, we now define the notion of an actual dialogue, i.e. a dialogue as it can actually evolve between the parties in a dispute. This boils down to defining the precise content of the ordered theory Γ referred to in Definition 4.1.

We first define some useful notation. Let us denote for any $BI = (Cases, CFS, CSRules)$ the set of all broadenings of any rule in *Rules-of-Cases* with $Broadenings_{BI}$ (note that $Rules\text{-}of\text{-}Cases \subseteq Broadenings_{BI}$) and the set of all rules distinguishing any rule in $Broadenings_{BI}$ with $Distinctions_{BI}$. Then $Introducibles_{BI} = Broadenings_{BI} \cup Distinctions_{BI}$. Thus this set does not only contain all rules of any case in $Cases_{BI}$ but also all rules that can be formed by broadening any of those rules, and by distinguishing any of those broadenings. Finally, for any sequence D or tree T of arguments, $Rules_{D/T}$ is the set of all rules occurring in D/T.

Then an actual dialogue, and the corresponding notion of an actual dialogue tree, are defined as follows.

Definition 5.4 *For any BI*

- *An* actual dialogue *based on BI is a dialogue D conforming to Definition 4.1 and based on* CFS $\cup$ CSRules $\cup$ Introducibles$_{BI}$*.*
- *An* actual dialogue tree *based on BI is a tree of actual dialogues based on BI.*

Note that we do not require that an actual dialogue tree contains all possible moves of the opponent.

An actual dialogue tree should not be confused with a dispute as it actually takes place. Rather, such a tree is a data structure which is built by the moves of the parties in a dispute. Below we assume that a disputational protocol exists for constructing an actual dialogue tree. However, since various such protocols are conceivable (e.g. 'extend all nodes at once' or 'extend one node'), we will not define a particular one. We confine ourselves to observing that any such protocol should allow for 'backtracking', i.e. for extending not only the leaves of the tree but also earlier nodes. This is necessary since it may be that a player's move introduces premises with which the other player can construct a new counterargument against an earlier move of the first player (this cannot happen in the dialectical proof theory of Section 4, where the ordered theory Γ is fixed).

5.4 Winning a dispute

Finally we define the outcome of a dispute. Assume that after $move_i$ in a dispute an actual dialogue tree T_i is constructed. Then the question is, who is winning at stage i, if any? Our answer should maintain the link with Definition 4.3 and thus with the semantics of [Prakken & Sartor, 1997a]. Now Definition 4.3 is relative to a given ordered theory, while the idea of our actual dialogues is that this ordered theory is constructed dynamically. So we have to define what the content is of the set Γ referred to in Definition 4.3.

Since in the present paper we focus on reasoning with precedents, we will assume that *CFS* and *CSRules* are fixed, i.e. that Γ at least contains these sets (although in other reasoning context they might also be constructed dynamically). Then two alternative contents of Γ suggest themselves. The first contains besides these sets all rules that are introducible: i.e.

(1) $\quad \Gamma = CFS \cup CSRules \cup Introducibles_{BI}$

The second only contains the introducible rules that have actually been introduced into the dispute. Accordingly, we now index Γ with the stage of the dispute.

(2) $\quad \Gamma_i = CFS \cup CSRules \cup (\mathrm{Introducibles}_{BI} \cap Rules_{T_i})$

The difference between the two ways of defining Γ is that the first formulates an *ideal* standard for disputes, requiring that the parties analogize and distinguish the available precedents in the best possible ways, while the second definition evaluates debates relative to the analogies and distinctions that have actually been made. In our view there is no need to choose which is the 'right' definition; both definitions may have their uses, depending on the context.

Finally, we can define the notion of winning an actual dialogue tree (leaving the content of Γ ambiguous between (1) and (2)).

Definition 5.5 *$Player_i$ wins an actual dialogue tree T_i iff*

1. *If $Player = P$ then all leaves of T_i are moves of P; and*
2. *If $Player = O$ then not all leaves of T_i are moves of P; and*
3. *$Player_{i+1}$ cannot extend T_i with arguments containing only rules from Γ_i.*

It is easy to see that condition (2) makes the link with Definition 4.3 and thus with the semantics of [Prakken & Sartor, 1997a] (note that if Γ is defined as in (1), then Condition (2) can become *'$Player_{i+1}$ cannot extend T_i.'*).

It is important to note that when the proponent uses a broadened rule, it can always be distinguished by the opponent. Therefore, if the opponent makes optimal use of its resources, a proponent can only win a debate if it does not draw analogies. This seems realistic, since with analogies the decision whether to regard the similarities or the differences as more important is in the end a matter of substance rather than of logical form.

6 Applying the protocol

In this section we will illustrate how our dialectical protocol can be applied to HYPO-style reasoning with precedents. We first have to comment on HYPO's more-on-point ordering on precedents. This will have to be modified, since a HYPO case concerns only one decision, while we allow precedents to be about multiple issues, each addressed by different portions of the precedent. We think that the 'more on point' relation can best be understood as applying to each of those individual portions. In [Prakken & Sartor, 1997b] we have generalised HYPO's definition to this effect, but space limitations prevent us from repeating it here.

We will now give an example, with a *BI* that extends and somewhat modifies our tax example.

The common-sense rules

We assume that the BI contains the following factors, which are added to *CSRules* as rules *factor* $\Rightarrow$ *supported conclusion.*

f_1: *kept-house* $\Rightarrow \neg$ *change*
f_2: $\neg$ *kept-house* $\Rightarrow$ *change*
f_3: *domestic-company* $\Rightarrow \neg$ *change*
f_4: $\neg$ *domestic-company* $\Rightarrow$ *change*
f_5: *short-duration* $\Rightarrow \neg$ *change*
f_6: *long-duration* $\Rightarrow$ *change*
f_7: *domestic-property* $\Rightarrow$ *domestic- company*
f_8: $\neg$ *domestic-property* $\Rightarrow \neg$ *domestic-company*
f_9: *domestic-headquarters* $\Rightarrow$ *domestic-company*

f_{10}: $\neg$ *domestic-headquarters* $\Rightarrow$ $\neg$ *domestic-company*
f_{11}: $\neg$ *domestic-president* $\Rightarrow \neg$ *domestic-company*
f_{12}: $\neg$ *domestic-job-prospects* $\Rightarrow$ *change*
f_{13}: *foreign-car* $\Rightarrow$ *change*

Note that we have a little complicated the example, by introducing an intermediate factor *domestic-company,* which is to be established on the basis of other factors.

The case base

The precedential knowledge base *Cases* consists of four (hypothetical) cases. The first is $A =$

$\{r_{2/4/6}$: $\neg$ *kept-house* $\wedge \neg$ *domestic-company* $\wedge$ *long-duration* $\Rightarrow$ *change*
f_2: $\neg$ *kept-house,* f_6*: long-duration,*
f_4: $\neg$ *domestic-company* $\}$

A is a simple case, with no factors con its decision. It contains the justified argument $[f_2, f_4, f_6, r_{2/4/6}]$ for *change.*

The second precedent is $B =$

$\{r_7$: *domestic-property* $\Rightarrow$ *domestic-company*
r_{10}: $\neg$ *domestic-headquarters* $\wedge \neg$ *domestic-president* $\Rightarrow \neg$ *domestic-company*
r_4: $\neg$ *domestic-company* $\Rightarrow$ *change*
r_1: *kept-house* $\Rightarrow \neg$ *change*
p_1: $\Rightarrow r_7 \prec r_{10}$
p_2: $\Rightarrow r_1 \prec r_4$
f_1: *kept-house,* f_7*: domestic-property,*
f_{10}: $\neg$ *domestic-headquarters* $\}$

B illustrates the stepwise construction of a decision: it contains the justified argument $[f_{10}, r_{10}, r_4]$, which supports its intermediate conclusion $\neg$ *domestic-company* and its final decision *change.*

The third precedent is $C =$

$\{r_2$: $\neg$ *kept-house* $\Rightarrow$ *change*
$r_{3/5}$: *domestic-company* $\wedge$ *short-duration* $\Rightarrow$ $\neg$ *change*
p_3: $\Rightarrow r_1 \prec r_{3/5}$
f_2: $\neg$ *kept-house,* f_3*: domestic-company,*
f_5: *short-duration* $\}$

C contains the justified argument $[f_3, f_5, r_{3/5}]$ for $\neg$ *change.* Finally, we have $D =$

$\{r_{2/12/13}$: $\neg$ *kept-house* $\wedge \neg$ *domestic-job-prospects* $\wedge$ *foreign-car* $\Rightarrow$ *change*
$r_{3/5}$: *domestic-company* $\wedge$ *short-duration* $\Rightarrow \neg$ *change*
p_4: $\Rightarrow r_{3/5} \prec r_{2/12/13}$
f_1: $\neg$ *kept-house,*
f_3*: domestic-company,*
f_5: *short-duration,*
f_{12}: $\neg$ *domestic-job-prospects,*
f_{13}: *foreign-car* $\}$

D contains the justified argument $[f_2, f_{12}, f_{13}, r_{2/12/13}]$ for *change.*

A dispute

Let us now illustrate our approach with the following dispute, based on the *CFS*

$\{f_2$*:* $\neg$ *kept-house,* f_3*: domestic-company,*
f_5: *long-duration,* f_{12}*:* $\neg$ *domestic-job-prospects* $\}$

We will assume that the dispute is evaluated with respect to the second definition of Γ. Accordingly, the dispute starts with $\Gamma_0 =$ *CFS* $\cup$ *CSRules.* The proponent wants to defend *change* and starts the dispute by citing A. In particular, P wants to use $r_{2/4/6}$, but since f_4 is missing in the CFS, P has to broaden this rule into $r_{2/6}$ (using the first clause of Definition 5.3). Then he can introduce this rule into the dispute with the following argument. (below we will leave the facts of an argument implicit).

P_1: $[r_{2/6}$: $\neg$ *kept-house* $\wedge$ *long-duration* $\Rightarrow$ *change*$]$

Now we have $\Gamma_1 = \Gamma_0 \cup \{r_{2/6}\}$.

In order to build an actual dialogue tree according to Definition 5.4, the opponent must now by clause (4) of Definition 4.1 state an argument that defeats P_1. O can do so by giving a counterexample to the precedent A used by P_1, viz. with respect to the factor *domestic-employer,* by drawing an analogy with precedent C.

O_1: $[r_{3/5}$: *domestic company* $\wedge$ *short-duration* $\Rightarrow \neg$ *change*$]$

This argument does not require the introduction of new rules: it just uses $r_{3/5}$ of C, so $\Gamma_2 = \Gamma_1$. According to our framework, O_1 defeats P_1, since its rule $r_{3/5}$ head-to-head conflicts with P_1's rule $r_{2/6}$ (recall that for assessing O's moves no priorities are used). At this stage the actual dialogue tree is $T_2 = P_1 - O_1$. This tree ends with a move by O and P cannot reply without introducing a new rule, so Definition 5.5 tells us that at this stage O is winning.

However, P can reverse the outcome, since P can strictly defeat O_1 by citing precedent D. This citation involves the introduction of a new rule: since rule $r_{2/12/13}$ from case D has an antecedent which lacks in the CFS, viz. *foreign-car,* P must broaden this rule into $r_{2/12}$. Moreover, to make its argument strictly defeating O_1, P states that its rule is based on a more-on-point precedent.

$$\begin{array}{lll} P_2\colon & [r_{2/12}\colon & \neg\, \textit{domestic-job-prospects} \wedge \\ & & \neg\, \textit{kept-house} \Rightarrow \textit{change} \\ & p_5\colon & \Rightarrow \textit{More-on-point}(r_{3/5}, r_{2/12}) \\ & \textit{mop}\colon & \textit{More-on-point}(r_{3/5}, r_{2/12}) \Rightarrow \\ & & r_{3/5} \prec r_{2/12}] \end{array}$$

We assume that the antecedent of p_5 is provided by an external procedure that applies the definition of 'on pointness'. According to our framework, P_2 strictly P_2-defeats O_1, since P_2 says that its rule $r_{2/12}$ is better than O_1's conflicting rule $r_{3/5}$.

The ordered theory is now $\Gamma_3 = \Gamma_2 \cup \{r_{2/12}\}$ and the actual dialogue tree is $T_3 = P_1 - O_1 - P_2$. This tree has just one branch, ending with a move by P; moreover, O cannot move without introducing a new rule, so at this stage P is winning.

However, this time O can reverse the outcome, since O can create a new branch of the tree by distinguishing P_1 with

$$O_1'\colon \quad [r\colon \quad \sim \neg\, \textit{domestic-property} \Rightarrow \neg\, \textit{change}]$$

The ordered theory is now $\Gamma_4 = \Gamma_3 \cup \{r\}$; note that r has been introduced by applying the second condition of Definition 5.3. Moreover, we now have an actual dialogue tree T_4 with two branches, viz. $P_1 - O_1 - P_2$ and $P_1 - O_1'$. Both branches end with a move by O, and P cannot extend the tree, so at this stage O is winning. Moreover, since P cannot even reply with introducing new rules, P cannot reverse this result.

Note that in the present protocol P can only distinguish O's moves if the priorities needed to make P distinction strictly defeating O's example are present in the BI. In many applications this will not be the case. It would be interesting to investigate how a protocol could also allow P to make distinctions.

7 Comparison with HYPO/CATO

In this section we will compare our analysis with the approach of HYPO/CATO. To start with, while HYPO and CATO are implemented systems, we have presented an abstract, logical framework, for which reason we have ignored many of the interesting knowledge-representation and implementation aspects of these systems. On the other hand, our level of abstraction facilitates a link with general logical insights, in particular with argument-based semantics of defeasible reasoning.

Secondly, while we have a 'normative' dialectical approach, where the aim is to test the tenability of a claim, HYPO and CATO have a more empirical or cognitive approach, focused more on the generation and less on the evaluation of debates. In particular, while our dialogue game has a dialectical asymmetry between the parties, since the proponent's moves must have stronger force than the opponent's moves, in HYPO/CATO the rules are in this respect the same for the proponent as for the opponent: in particular, a plaintiff's move is OK if it is not weaker than the preceding defendant's move.

Although we have presented a formal analysis, it is not difficult to imagine how our protocol, or a modified version, could also be used to generate dialogues. With this in mind, we can observe the following differences between our approach and HYPO/CATO.

Firstly, an advantage of HYPO/CATO is that it models reasoning with hypothetical precedents, and that it allows for non-boolean factors. It seems to us, however, that there are no theoretical objections to extending our analysis with these features.

Perhaps the two most important advantages of our system are that, firstly, our system can, unlike HYPO's 3-ply and CATO's 4-ply arguments, model dialogues of arbitrary depth, and secondly, that our system allows substantive debates on the criteria for comparing precedents.

As we have already seen, our system refines the case representations of HYPO/CATO, by allowing the explicit representation of intermediate decisions. Among other things, this allows us, like [Branting, 1991], to model the use of portions of precedents in a new argument. Consider, for instance, Case B and assume also that another precedent says that a domestic company of a certain type falls under a certain tax regime; then B can be used to argue that a company is domestic, perhaps even combined with another precedent on the type of company.

Some final differences are that our representation method also allows us to express conflicting views of precedents on relations between factors, while CATO has just one factor hierarchy, and that our language allows the expression of information about rules, for instance on their purposes; this makes it possible to capture teleological aspects of case-based reasoning, as we hope to show in future publications.

To conclude this comparison, we can say that our system extends and refines the HYPO/CATO approach on a number of important points. However, unlike HYPO and CATO, our system has not yet been implemented, nor has it been extensively tested in a real legal domain. It is a challenging task to match the HYPO and CATO systems also in these respects.

8 Related research

To our knowledge the first logical analysis of case-based reasoning in law was [Loui et al., 1993], further developed in [Loui & Norman, 1995], who analyze the use of rationales in legal argument in a dialectical setting. Our idea to represent cases as a collection of possibly conflicting arguments was inspired by [Loui & Norman, 1995], who use the method in formalising a certain type of rationale of precedents, a so-called 'disputation rationale'. Their idea is that a party can attack the use of a certain precedent by arguing that the ratio decidendi of the precedent was in fact the result of a choice between conflicting arguments, and that in the new fact situation the outcome of the dispute would have been different.

Hage [1996] gives, in the context of his 'reason-based logic' a representation method for cases that is similar to ours in that it separates the reasons pro and con and expresses the resolution of their conflict in the representation language. However, his method is not embedded in a dialectical context.

Vreeswijk [1996] has earlier embedded HYPO-style reasoning in a dialectical protocol, but since this is not the main theme of his paper (which is reasoning about protocol), his analysis is simpler and less detailed than ours: in particular, he does not generalise HYPO's case representation method, he does not formalise reasoning about priorities and he does not discuss ways of distinguishing precedents.

Finally, we briefly compare our model with Gordon's [1995] Pleadings Game, which formalizes and implements civil pleading as a dialogue game. Like the Pleadings Game, our model allows the introduction of premises during a dialogue. However, while Gordon's model allows the introduction of any piece of information (as long as it is relevant to the discussion), in our model the only way to introduce new premises is by analogical reasoning; the background information is assumed to be given in advance (like in HYPO/CATO). On the other hand, the Pleadings Game does not account for analogical reasoning with legal precedents. These differences result from the fact that while Gordon focuses on the *speech act* aspects of theory construction, we focus on (one of) its *heuristic* aspects. We believe that the two models can very well be combined. This would augment the Pleadings Game with an account of reasoning with precedents, and our model with the speech act aspects of the Pleadings Game.

9 Conclusion

Concluding, we can ask what has been gained by our logical analysis of HYPO-style reasoning with precedents. We think we have gained a number of things. Firstly, we have been able to suggest some refinements and adjustments of the HYPO/CATO approach. Moreover, we have seen that several of HYPO/CATO's features are a special case of a general theory of defeasible argumentation, which (we hope) illuminates these aspects of HYPO/CATO.

As for future research, it would be interesting to investigate other structured ways of introducing information into a dispute. For instance, we could allow for other forms of analogical reasoning, such as those based on abstraction. And it would be interesting to see if later research on case-based reasoning and its integration with rule-based reasoning (e.g. [Skalak & Rissland, 1992], [Aleven & Ashley, 1996]) can be defined in our dialogue game as heuristics for playing the game.

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