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# Modelling Defeasibility in Law: Logic or Procedure?*

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**Abstract.** This paper investigates whether current nonmonotonic logics are suitable for formalising the defeasibility of legal reasoning. It does so by studying the role of burden of proof in legal argument, in particular how allocations of burden of proof determine the required strength of counterarguments. It is argued that the two currently available modelling approaches both have some shortcomings. On the one hand, techniques for modelling burden of proof in nonmonotonic logics do not allow for shifts of the burden of proof from one party to the other. On the other hand, current procedural models of legal argument are too rigid, in that every counterargument induces a shift of proof burdens; this fails to respect that in legal reasoning burden shifts only occur in some cases. It is then shown how current dialectical models of defeasible reasoning can be adapted to overcome these shortcomings.

## 1. Introduction

It is widely accepted that legal reasoning is defeasible, but its proper formalisation is subject to some controversy. A popular approach is to use a nonmonotonic logic; see e.g. [25, 10, 27, 18]. However, some, e.g. Allen & Saxon [1] have argued that the defeasible nature of legal reasoning is irreducibly procedural, which cannot be captured by current nonmonotonic logics, since these systems define defeasible consequence not in procedural terms but as a 'declarative' relation between premises and conclusion of an argument (cf. also [14, 15]). Allen & Saxon criticise Sergot *et al.* [26], who formalise 'unless shown otherwise' phrases in legal rules with logic programming's negation as failure. Allen & Saxon argue that 'shown' in these phrases does not mean 'logically proven from the available premises' but "shown by a process of argumentation and the presenting of evidence to an authorized decision-maker". So 'shown' would not refer to logical but to legal-procedural nonprovability.

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In this article I examine this controversy by investigating the concept of burden of proof. This is one of the central notions of legal procedure, and it is clearly connected with defeasibility [12, 2, 7, 8, 16, 14, 25]. The connection goes both ways: defeasibility induces certain burdens of proof, and allocations of the burden of proof make the reasoning defeasible. The aim of this paper is to examine whether 'declarative' nonmonotonic logics are sufficient for modelling reasoning under burden of proof. It will turn out that the answer is largely negative, which supports the legal-procedural view on defeasibility in law.

Let me delineate the precise issues to be discussed and review the relevant work in the literature. There are two aspects of having the burden of proving a claim: the obligation to come with an argument for that claim, and the obligation to uphold this argument against challenge in a dispute. As for the first aspect, this could be formalised in MacKenzie-style dialogue systems [17, 29], which regulate such speech acts as claiming, challenging, conceding, withdrawing and arguing for a proposition. However, such dialogue systems do not allow for counterarguments and therefore cannot formalise the second aspect of burden of proof. Here is where nonmonotonic logics come in. For instance, several dialectical protocols for dispute have been developed, which regulate the adducing of and adjudication between conflicting arguments (see e.g., [15, 28, 22]); most of these protocols are based on so-called logics for defeasible argumentation, or on other nonmonotonic logics, (see further Section 2). [6] and [9] have already studied the burden of proof in the context of such dialectical protocols. Moreover, because of their dialectical nature, these protocols for dispute can very well be combined with MacKenzie-style dialogue systems. In the area of artificial intelligence and law, several such combined models have already been proposed [11, 7, 8, 3, 13].

Part of my investigations will concern the adequacy of these approaches. I shall argue that the techniques based on declarative nonmonotonic logics are insufficient, since they do not allow for a shift of the burden of proof from one party to the other; to model this, procedural notions are also needed. However, I shall also argue that some of the above-mentioned procedural models of legal argument are still too rigid, since they make every counterargument induce a shift of proof burdens. This neglects the fact that in legal reasoning burden shifts only occur when indicated by procedural law.

As for the scope of this paper, I shall not propose a full model of legal procedure, covering both aspects of burden of proof. I shall only pay attention to the second aspect, defending an argument in dispute (cf. [7, 8]'s 'dialectical graphs', which are the dialectical core of the pleadings procedure). I shall also abstract from the *process* of allocating the burden of proof (which is a task of a judge in a legal procedure) and from the *reasoning* involved. In other words, I shall not try to formalise rules for burden-allocating speech acts, nor shall I formalise the application of legislation, case law and principles to determine the proper allocation of burden of proof. I shall only look at the *result* of these activities, viz. a given allocation of burdens of proof to the plaintiff and defendant in a dispute.

My investigations will take place at the background of a four-layered picture of legal argument, which I earlier proposed in [18]. The first, *logical* layer, provides the logical structure of single arguments, i.e., it defines how pieces of information can be combined in order to provide basic support for a proposition. The second, *dialectical* layer, focuses on conflicting arguments: it introduces such notions as 'counterargument' and 'defeat', and it defines, given a set of arguments and their defeat relations, which arguments can be accepted as justified. This is the

layer modelled by nonmonotonic logics, most directly by so-called 'logics for defeasible argumentation'. The third, *procedural* layer, regulates how an actual dispute can be conducted, i.e., how parties can introduce or challenge new information and state new arguments. Among other things, this level defines the possible speech acts, and the discourse rules for when and how these speech acts can be performed. The final layer, the *strategic* or *heuristic* one, provides rational ways of conducting a dispute within the procedural bounds stated at the third level. The procedural and strategic layer differ from the first two layers in one crucial respect. While the logical and dialectical layer assume a fixed set of premises, at the procedural and strategic layer the set of premises is constructed dynamically, during a debate. MacKenzie-style dialogue systems only have the logical and procedural layer, while the above-mentioned AI & law models of legal procedure also contain the dialectical layer.

I can now give a precise formulation of the problem statement. The problem is whether a given allocation of burden of proof and the way it influences the conclusions that can be drawn can be completely modelled at the second, dialectical layer, or whether the third, procedural layer is also needed. It should be noted that this question is the same as asking whether reasoning with burden of proof can be modelled in nonmonotonic logics: this is since such logics have a natural translation into logics for defeasible argumentation; cf. [24].

In Section 2 I introduce these argumentation logics, after which in Section 3 I give a more detailed analysis of reasoning with burden of proof, using some examples from Dutch law. Based on this analysis, I shall then modify the dialectical form of argumentation logics in Section 4, and apply it to the examples in Section 5. I end with a discussion of the just-mentioned related research (Section 6) and with some conclusions (Section 7).

## 2. Logical preliminaries

The coming discussion will be in terms of logics for defeasible argumentation. Therefore, a brief description of such logics is now in order. For a detailed overview the reader is referred to [24]. As said above, argumentation systems define such notions as counterarguments, or attack, and defeat among arguments, and they define the dialectical status of an argument.

*Attack* on arguments can have several forms, viz. attacking a conclusion, an assumption or an inference step of an argument. That an argument *defeats* another means that it attacks it and is not weaker; an argument *strictly defeats* another argument if it attacks it and is stronger, i.e., if it defeats and is not defeated by that argument. The criteria for strength of an argument are in general domain dependent, and can themselves be subject of debate.

Finally, taking all defeat relations into account, the dialectical status of the constructible arguments is defined. A declarative framework for this aspect has been developed by Dung [5], who has studied several stability conditions for status assignments to sets of arguments. On top of these assignments, arguments can be divided 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. (Note that these notions are relative to a given pool of premises from which arguments can be constructed.) A formula is a justified consequence of the premises if a justified argument for it can be constructed.

What for present purposes is very relevant is that logics for defeasible argumentation can

be stated in the dialectical form of an argument game, where the proof that a formula has a certain status takes the form of a dialogue between a proponent and an opponent of the formula. For the purpose of this paper, proofs of justification are especially relevant. In such proofs, the proponent starts with an argument for the formula, after which the players take turns: each following move consists of an argument that attacks the last move of the other player with a certain minimum force, depending on the dialectical role of the player. Since the proponent wants the initial argument to be justified, his moves have to be strictly defeating, while since the opponent instead wants to prevent the initial argument from being justified, her moves may be just defeating. Now the initial argument is provably justified if the proponent has a *winning strategy* in this game, i.e., if he can make the opponent run out of moves whatever moves she makes.

In [4] Dung has formalised these ideas in a dialectical proof theory for the so-called grounded semantics of his 1995 framework. It assumes the following notions.

- A notion of *argument*. While Dung leaves the structure of arguments completely unspecified, for present purposes some structure must be assumed: arguments will be trees of inferences, where the validity of these inferences is determined by some underlying monotonic logic. The root of an argument is its *conclusion*. I shall sometimes denote the conclusion of an argument $A$ by $CONC(A)$. An argument also has *subarguments*, viz. all its subtrees, and it has *superarguments*, viz. all arguments of which it is a subargument. I assume that defeat is defined such that if an argument is justified, all its subarguments are also justified. Thus one way to defeat an argument is by defeating one of its subarguments.
- A binary relation of *defeat*[1] among arguments. Just as Dung, I shall leave its origin unspecified. $A$ *strictly defeats* $B$ if $A$ defeats $B$ but not vice versa.
- An *argumentation theory*, which is a set of arguments ordered by a defeat relation. Usually, this set is determined by a set of premises which serves as the basis for discussion, i.e., from which the arguments can be constructed in the underlying monotonic logic.
- Two players, a *proponent* $P$ and an *opponent* $O$. For each player $p$, the other player is denoted by $\overline{p}$.

A dialogue is then defined as follows.

**Definition 2.1.** (dialogues.) A *dialogue* is a nonempty sequence of moves $M_1, \ldots, M_n, \ldots$ where each $M_i$ is of the form $(Player_i, Arg_i)$, and where

1. $Player_i = P$ iff $i$ is odd; and $Player_i = O$ iff $i$ is even;
2. If $Player_i = Player_j (i < j)$ then $Arg_i \neq Arg_j$;
3. If $Player_i = P$ $(i > 1)$ then $Arg_i$ strictly defeats $Arg_{i-1}$;
4. If $Player_i = O$ then $Arg_i$ defeats $Arg_{i-1}$.

A dialogue is *based on* an argumentation theory $AT$ iff $AT$ includes all arguments moved in the dialogue, and all their defeat relations.

[1] Dung uses the term 'attack' instead of 'defeat'.

The first condition says that the proponent begins and then the players take turns, while the third and fourth condition state the required forces of $P$'s and $O$'s moves. The second condition forbids the proponent to repeat his moves. This condition ensures that dialogues are finite if there are finitely many arguments. It does not influence provability, since if the opponent had a reply the first time, she will also have a reply the second time, and infinite dialogues cannot be won by the proponent.

Winning and justification are then defined as follows.

**Definition 2.2.** (winning, justification.) A player *wins* a dialogue iff the other player cannot move. An *argument* $A$ is *justified* on the basis of an argumentation theory $AT$ iff the proponent has a winning strategy in any dialogue based on $AT$ that begins with $A$. A *formula* is *justified* iff it is the conclusion of a justified argument.

In [23] grounded semantics and its argument game are extended with the means to model disputes about the defeat criteria. For legal applications this is very important, but for simplicity I shall ignore this here.

To give an example of the dialogue game, consider the two trees of dialogues in Figure 1. The tree on the left is based on an argumentation theory $AT_1$ with the arguments $\{A, B, C, D, E, F, G\}$ and the defeat relations as shown by the arrows. Here the proponent $P$ has a winning strategy, since in all dialogues the opponent $O$ eventually runs out of moves; so argument $A$ is provable on the basis of $AT_1$. The tree on the right is based on an extension of $AT_1$ to $AT_2$ by adding the arguments $H$, $I$ and $J$ and new relations corresponding to the new arrows (the extension is shown inside the dotted box). Here $P$ does not have a winning strategy, since one dialogue ends with a move by $O$; so $A$ is not provable on the basis of $F_2$.

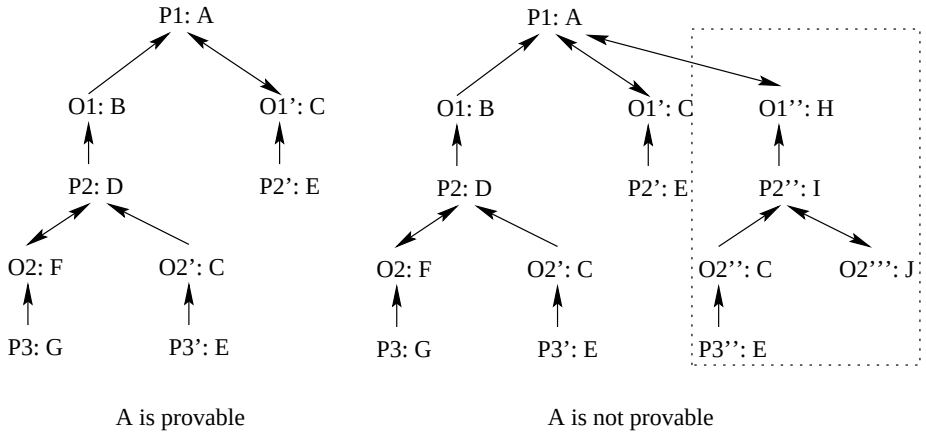


Figure 1. Two trees of proof-theoretical dialogues.

At the dialectical layer, this argument game serves as a logical proof theory. However, as shown in [22], it can be reinterpreted as part of a procedure for actual disputes between real players, by dropping the assumption of a fixed pool of premises from which arguments can be constructed. Thus a natural link can be established between the dialectical and procedural level of legal argument; such a link will be a necessary component of a full model of reasoning with burden of proof.

## 3. Informal analysis of reasoning with burden of proof

Above I said that there are two aspects to having the burden of proof, viz. the obligation to provide an argument for a claim and the obligation to defend this argument in dispute. The second obligation, which is the topic of this article, in turn has three aspects.

The first is whether an argument in itself sufficiently supports its conclusion, apart from possible counterarguments. This can vary between specific procedures. For instance, in Dutch criminal law analogical rule application is not allowed, but in other areas of Dutch law it is acceptable. Even within a procedure a judge is sometimes free to assess the strength of arguments (as is the general rule in Dutch civil law) while at other times the evidence is *conclusive*, i.e., in the absence of counterevidence the judge must accept its conclusion. For instance, in Dutch law an 'authentic act' (in English law an 'avidavit'), i.e., an official document containing statements by a legal official, is conclusive evidence that its content is true.

The second question is whether counterarguments are allowed. This is also a matter of law. Many legal procedures declare certain kinds of evidence *incontrovertible*, in that no counterevidence is allowed. This holds, for instance, in Dutch civil law for a so-called 'decisive oath' of one of the parties.

The final question is how strongly arguments must defeat their counterarguments. This partly depends on the allocation of burden of proof: the arguments of the party that has the burden of proof must be strictly defeating, while the other parties' arguments can be simply defeating. However, this also depends on the type of procedure. For instance, in American criminal law a claim must be proven 'beyond reasonable doubt', while in American civil law it suffices to prove a claim 'on the balance of probabilities'. Such a difference can be incorporated in more or less strong criteria for (strict) defeat.

In this article I am only concerned with the third question, and then only with how the answer is determined by the allocation of the burden of proof. As for the first two questions, I shall simply assume that all arguments have passed the test of internal strength, and that counterarguments are always possible.

With the logical tools of the previous section, the problem statement can now be restated as follows. Suppose the plaintiff and defendant in a legal case have both been assigned certain burdens of proof. Can we formalise this by regarding plaintiff's burdens as claims that he as proponent in our argument game has to show justified, and by regarding defendant's burdens as claims that, if she as opponent shows them to be defensible, prevent the proponent's main claim from being justified? If so, then it suffices to apply the rules of our argument game to the arguments adduced in the dispute, and to check whether the proponent has a winning strategy in this game for his main claim.

I shall now discuss an example (from contract law) showing that in general the answer is negative. In legal systems it is generally the case that the one who argues that a valid contract exists has the burden of proving those facts that ordinarily give rise to the contract, while the party who denies the existence of the contract has the burden of proving why, despite these facts, exceptional circumstances prevent the contract from being valid. Now suppose that plaintiff claims that a contract between him and defendant exists because plaintiff offered defendant to sell her his car, and defendant accepted. Then plaintiff has the burden of proving that there was such an offer and acceptance (and usually some other conditions, which will be ignored here).

Suppose plaintiff ($\pi$) does so with witness testimonies. In structured natural language:

$\pi_1$:
(1) Witnesses John and Bill say that there was an offer and acceptance
(2) John and Bill are reliable witnesses
(3) If reliable witnesses say that something happened, then it happened
---
So, (4) there was an offer and acceptance
(5) If there was an offer and acceptance, then a valid contract was created.
---
So, (6) a valid contract was created.

Suppose now that defendant ($\delta$) wants to attack this argument by arguing that the witnesses are unreliable, since they lied on other occasions. So defendant wants to attack premise (2) of $\pi_1$. In structured form:

$\delta_1$:
(7) John and Bill lied before
(8) If persons lied before, they are unreliable witnesses
---
So (9) John and Bill are unreliable witnesses.

Note that (9) contradicts (2). Suppose now also that the judge has allocated the burden of proving the witnesses' reliability to plaintiff. How strong must defendant's counterargument then be? It seems that, since defendant's attack relates to a proposition that plaintiff must prove, her counterargument can be merely defeating. So thus far, the rules of our argument game apply. To state this in perhaps more familiar legal terms, it is not necessary that the judge becomes convinced that the witnesses are not reliable; it suffices that the judge is not convinced that they are reliable. (In argumentation systems the judge's convictions can be expressed in metalevel arguments about the strength of conflicting arguments; however, because of space limitations such metalevel arguments will be left implicit here.)

However, suppose now that defendant concedes plaintiff's claims concerning offer and acceptance, and instead attacks plaintiff's argument by claiming an exception, viz. that she was insane when she accepted plaintiff's offer.

$\delta_1'$:
(10) I was insane when accepting the offer
(11) If somebody is insane when accepting an offer, no valid contract is created
---
So, (12) no valid contract was created.

Note that (12) contradicts (6). In any legal system defendant has the burden of proving insanity. What does this mean for the relative strength of her argument? The rules of our argument game again say that this argument merely has to defeat plaintiff's first argument, but this time this seems too weak: since the defendant has the burden of proving this exception, it seems that her argument should *strictly* defeat plaintiff's main argument. In other words, it is not sufficient that the judge is not convinced of her sanity; instead the judge must be convinced of her insanity. So an allocation of a burden of proof to the defendant seems to induce a switch in the dialectical

roles: as far as the issue of defendant's insanity is concerned, defendant is the proponent and plaintiff is the opponent.

We can draw a first conclusion from this example: burden of proof is usually distributed over the parties in a legal dispute, which means that both parties can be proponent on some issues but opponent on other issues. Clearly, this is not captured by the rules of our logical argument game.

The situation is even more complicated. Suppose that the defendant, in her role of proponent of insanity, attempts to prove her insanity with an official-looking document containing a judicial decision declaring her insane. So instead of with $\delta_{1'}$, she moves with

$\delta_1''$:
(13) This document is a document of court $C$
(14) This document declares me insane at the time of the offer.
(15) If a court's document declares someone insane, s/he is insane.

---

So, (10) I was insane when accepting the offer
(11) If somebody is insane when accepting an offer, no valid contract is created

---

So, (12) no valid contract was created.

And suppose that the plaintiff then claims that this document is not authentic because it does not contain the right stamp of court $C$.

$\pi_2$:
(16) This document does not contain the correct stamp of court $C$.
(17) If a document does not contain the correct stamp of a court,
it is not an authentic document of that court.

---

So, (18) this document is not a document of court $C$.

Here, (18) contradicts (13). Now in Dutch law the burden of proving that a document with seemingly official legal status is not authentic, is on the one who claims this, so in Dutch law the dialectical roles would switch again: with respect to the authenticity of the document, plaintiff becomes the proponent while defendant becomes the opponent. In other words, the judge must become convinced that the document is not authentic, otherwise defendant's argument $\delta_1''$ remains uncontested, and plaintiff's main claim cannot be proven. So we can draw a second conclusion: allocations of burden of proof can be nested, and moreover, they can be reversed in such a nesting. Clearly, the above argument game cannot model this.

It is important to note that these problems do not only arise in argumentation logics, but in nonmonotonic logics in general. This follows from the above-mentioned fact that nonmonotonic logics can be translated into argumentation logics.

What must be added to our argument game to let it cope with these phenomena? Perhaps several solutions are possible, but in this paper I shall explore the following one. I shall assume an explicit allocation of burdens of proving certain propositions to the parties in a dispute, and I shall distinguish between the parties in a dispute (plaintiff and defendant) and the dialectical roles that they can have (proponent and opponent). If a party uses an argument for a conclusion which s/he has to prove, then this party at that point in the dispute becomes the proponent, with the corresponding task to strictly defeat the other party's argument. The other party, now

the opponent, then just needs to defeat the new proponent's argument. Clearly, this solution introduces a procedural notion into our model, so that we have shifted from the dialectical to the procedural level.

Finally, I shall illustrate with a new example two other aspects that have to be captured.

First I show that the players' dialectical role sometimes depends on the point at which it attacks the other player's argument. In Dutch law factual possession of a good creates the presumption that a claimed right to that good (e.g. ownership) indeed exists. Challenging this presumption induces the burden of proving otherwise. Consider now the legal rule that damaging a good constitutes an obligation to pay for the damages to the owner of the good, and consider a case where plaintiff claims that defendant ought to pay for damaging his car, and proves his ownership by pointing at his possession of the car. It now matters at which point defendant directs her attack. If she attacks plaintiff on his subargument concerning ownership, then she has the burden of proving that plaintiff does not own the car. However, if she attacks plaintiff's claim that she has damaged plaintiff's car, it suffices for her to cast doubt, since on this issue the burden of proof rests with the plaintiff. So we must capture that a parties' dialectical role can be different relative to different parts of an argument.

This example also illustrates that even with respect to the same issue the burden of proof can shift. Since possession is conclusive evidence of ownership, as soon as plaintiff has proven his ownership with his possession of the car, the burden of proving that he is not the owner shifts to the defendant. So we must also capture that allocations of the burden of proof are relative to a stage in a dispute.

## 4. A formalisation of reasoning with burden of proof

In this section I shall formalise my analysis of Section 3, by extending the argument game of Section 2 with notions concerning burden of proof.

- I now distinguish between the *players* in a dialogue (plaintiff and defendant) and the *dialectical roles* that they can have at the various stages of the dialogue (proponent or opponent). Plaintiff always starts a dialogue. Actually, since we have seen that the role of a player is relative to different parts of the argument, I shall below simply speak of the dialectical role of an argument.
- Finally, and crucially, I assume an explicit *allocation of burden of proof* to the players, which is used in determining the role of an argument moved at that stage. At each stage of a dialogue, each player is assigned a (possibly empty) set of propositions to prove.

In formalising the above analysis, I start with the new 'top level' definition, i.e., with the new definition of a dialogue. The idea is simply to say that the required force of an argument depends on its dialectical role when moved (which role will be defined further on). Before we can give this new definition, one subtlety must be discussed, viz. repetition of moves. Must this be allowed for arguments moved in a different role? Without a semantics this question is not easy to answer. However, the problem largely seems artificial, since realistic examples with such repetitions are hard to imagine. Yet a choice must be made, and I shall apply the following principles. Clearly, a *P*-*P* repetition must still be disallowed and an *O*-*O* repetition must still

be allowed. Further, I shall disallow a $P$-$O$ repetition, since the mover must dialectically prove the argument and we do not want that an argument indirectly defends itself. Finally, I shall allow an $O$-$P$ repetition, since the first time the mover did not yet have to prove the argument.

Now the new dialogue game can be defined. It suffices to replace proponent and opponent as players by plaintiff ($\pi$) and defendant ($\delta$), to replace the old nonrepetition rule with the new one, and to say that the defeating force of a moved argument depends on its dialectical role.

**Definition 4.1.** (dialogues with burden of proof.) A *dialogue with burden of proof* is a nonempty sequence of moves $M_1, \ldots, M_n, \ldots$ where each $M_i$ is of the form $(Player_i, Arg_i)$, and where

1. $Player_i = \pi$ iff $i$ is odd; and $Player_i = \delta$ iff $i$ is even;
2. If $Player_i = Player_j (i < j)$ and $Role(Arg_i) = P$, then $Arg_i \neq Arg_j$;
3. If $Role(Arg_i) = P$ $(i > 1)$, then $Arg_i$ strictly defeats $Arg_{i-1}$;
4. If $Role(Arg_i) = O$, then $Arg_i$ defeats $Arg_{i-1}$.

The winning condition stays the same: a player has won a dialogue if the other player cannot move.

It is left to define the allocation of the burden of proof, and to use it in defining the dialectical role of an argument.

Technically, an allocation of burdens of proof is a function from players and dialogues to propositions.

**Definition 4.2.** (burden of proof) Let *Args* be a set of arguments, $L$ the language of the underlying logic for constructing arguments, and *Dialogues* the set of all sequences of pairs $(Player, Arg)$, where $Player \in \{\pi, \delta\}$ and $Arg \in Args$. Then *Burdens* is a function that assigns to each player at each point in a dialogue a set of formulas to be proven:

$$Burdens\colon Dialogues \times \{\pi, \delta\} \longrightarrow Pow(L)$$

such that

- At each stage $i$:
  - The set of formulas a player has the burden of proof is consistent and deductively closed;
  - If $\varphi \in Burdens_i(p)$, then $\varphi \notin Burdens_i(\overline{p})$ and $\neg\varphi \notin Burdens_i(\overline{p})$.
- Between stages:
  - If $\varphi \in Burdens_i(p)$[2] and $Player_i = p$ and for no subargument $A$ of $Arg_i$, $CONC(A) = \varphi$, then $\varphi \in Burdens_{i+1}(p)$.
  - If $\varphi \in Burdens_i(p)$ and $Player_i \neq p$ then $\varphi \in Burdens_{i+1}(p)$.

[2] For notational convenience $Burdens(i, p)$ will be written as $Burdens_i(p)$.

The first condition 'between stages' says that one can only relieve oneself from a proof burden by meeting it, and the second condition says that a player cannot lose proof burdens by moves of the other player.

It would also be interesting to study 'minimality' or 'relevance' conditions on burden allocations, such as that every allocated proof burden must be relevant for the status of the main claim. However, I think that the most natural treatment of such conditions is in a full model of all aspects of reasoning with burden of proof.

As for the *dialectical role* of an argument, without explicit allocations of burdens of proof things were simple: since plaintiff wants to prove his main claim as justified, while defendant wants to prevent this, plaintiff's arguments always had the proponent role ($P$), while defendant's arguments always had the opponent role ($O$). However, now the role of an argument depends on the burden of proof, i.e., whether a move is an attempt to meet a burden or to prevent it from being met.

Recall that we must formalise the following phenomena. If the conclusion of an argument must be proven by the argument's mover, then it has the proponent role, whatever role the attacked argument has. Otherwise, the role of an argument is the opposite of that of the attacked argument. For this, we must look recursively higher up in the dialogue, until we encounter another explicit allocation of burden of proof, or else the first move, which is moved by plaintiff, which always has the proponent role. Recall also that different parts of an attacked argument can have different dialectical roles, so that it matters at which point an attack is targeted.

A technical complication is that sometimes an argument attacks another argument at more than one point. However, I have not been able to find realistic examples of this situation, and therefore I shall assume that it never arises. This allows the following simple definition of a 'defeat target' in an argument.

**Definition 4.3.** (defeat target.) Suppose $A$ attacks $B$. Then $B'$ is $A$'s *defeat target* in $B$ iff $B'$ is $B$'s smallest subargument attacked by $A$.

Now we can define the dialectical role of an argument as follows.

**Definition 4.4.** (dialectical roles.) Let $M_i = (Player_i, Arg_i)$ be any move in a dialogue with burden of proof, let $D_{i-1}$ be the dialogue upto but not including $M_i$, and let $A$ be any subargument of $Arg_i$. Then $Role_{M_i}(A)$, the *role* of $A$ in $M_i$ is defined as follows.

1. If $i = 1$, then $Role_{M_i}(A) = P$.
2. If $i > 1$, then
   (a) $Role_{M_i}(A) = P$ if $CONC(A) \in Burdens_{D_{i-1}}(Player_i)$;
   (b) else
      i. if $A$ defeats $Arg_{i-1}$, then $Role_{M_i}(A)$ is the opposite of the role of $Arg_i$'s defeat target in $Arg_{i-1}$;
      ii. else $Role_{M_i}(A)$ is the role of $A$'s smallest superargument in $Arg_1$ that is not identical to $A$.

Condition 2(b)ii regulates the role of the subarguments of the moved argument in case they are not assigned a role by the other conditions. This condition is not relevant for the required force of the moved argument but only for the role of eventual attackers, viz. when they attack a subargument of $Arg_1$ rather than $Arg_1$ itself.

# 5. Applying the model

In this section I apply the new dialogue game to the examples of Section 3. I shall formalise them in a particular argumentation logic, viz. that of [23]. Therefore, I first discuss this system and the formalisation method to be used below.

## 5.1. A method for representing rules and exceptions

The logical language of the system of [23] consists of rules of extended logic programming with two kinds of negation, classical negation ($\neg$) and negation as failure, or weak negation ($\sim$). Facts are represented as rules with empty antecedents. Arguments can be formed by chaining rules into trees (where weakly negated antecedents can be ignored); the root of an argument is its conclusion. Arguments can be attacked by attacking their (sub)conclusion(s) or negation-as-failure assumptions. If a conclusion is attacked, then defeat depends on a priority ordering on the rules. In the examples I shall for simplicity leave the priority considerations implicit.

As for representing rules and exceptions, the literature on nonmonotonic reasoning offers several techniques; see e.g. [18, Ch. 5] and [25] for legal applications. Consider a general rule 'if $a$ then $c$' with exception $b$. To formalise this, usually either nonprovability clauses are used, as in $a \wedge \sim b \Rightarrow c$, or implicit exceptions, as in $a \Rightarrow c$ vs. $a \wedge b \Rightarrow \neg c$, where the second rule is given priority over the first since it is more specific. However, for present purposes a disadvantage of these techniques is that they are not neutral with respect to burden of proof: in both of them, it does not make sense to allocate the burden of proving $\neg b$ to the one who claims $c$, since the logical form of the rule(s) does not require that $\neg b$ holds in order to construct an argument for $c$. For present purposes a neutral representation is desirable, since in reality the burden of proof may depend on the specific circumstances of the case, and also since legal doctrine on burden of proof might change while the material law stays the same. Therefore, it seems better to use the following convention. The absence of the exception $b$ is added to the general rule as an ordinary condition, viz. as $a \wedge \neg b \Rightarrow c$. (If desired, the exception clause can be general, saying no more than that there is no exception.) Then if the burden of proving the exception is on defendant, plaintiff may simply state its absence without grounds, i.e., as a rule with empty antecedent $\Rightarrow \neg b$. But if the burden of proving the absence of the exception is on plaintiff, he must give a nontrivial argument for $\neg b$. Thus, debates on burden of proof need not be regarded as debates on logical form. This is the method used in the examples below. However, the definitions of Section 4 will also apply to the other two methods.

## 5.2. Examples

I now use this method in my formalisation of the examples of Section 3. I leave it to the reader to verify that the new dialogue game also works well if nonprovability clauses or implicit exceptions

are used.

First I show that the definitions induce the wanted results in the contract example. Recall that our dialectical protocol is assumed to be embedded in a 'surrounding' protocol for making, challenging and withdrawing claims, and that the burden of proof is assigned by the judge in that surrounding protocol, viz. if one party makes a claim and the other party challenges it. Now assume that the procedure has started with plaintiff's claim that a contract between him and defendant exists, that defendant has challenged this, and that the judge has allocated the burden of proving the contract's existence to plaintiff:

$$\begin{array}{ll} Burdens_{\emptyset}(\pi) = & \{contract\} \\ Burdens_{\emptyset}(\delta) = & \emptyset \end{array}$$

Plaintiff fulfills his obligation to provide an argument for *contract* by moving the following argument.

$\pi_1$:
(1) $\Rightarrow$ *witnesses*, (2) $\Rightarrow$ *reliable*,
(3) *witnesses* $\wedge$ *reliable* $\Rightarrow$ *offer* $\wedge$ *acceptance*,
---
so (4) *offer* $\wedge$ *acceptance*.
(4') $\Rightarrow \neg Exc5$, (5) *offer* $\wedge$ *acceptance* $\wedge \neg Exc5 \Rightarrow$ *contract*,
---
so (6) *contract*.

Defendant now challenges *offer*$\wedge$*acceptance* after which the judge decides to add this to plaintiff's proof burdens. Defendant further claims that the witnesses are not reliable, which is challenged by plaintiff. The judge then decides that proving the reliability of the witnesses is part of the fulfilment of the burden of proving *offer* $\wedge$ *acceptance*. So the proof burdens at this point are:

$$\begin{array}{ll} Burdens_{\pi_1}(\pi) = & \{contract, offer \wedge acceptance\} \\ Burdens_{\pi_1}(\delta) = & \emptyset \end{array}$$

Alternatively, *reliable* could also have been explicitly added to plaintiff's burden, but in this case this is not necessary, since plaintiff's subargument for *reliable* inherits the proponent role from its superargument for *offer* $\wedge$ *acceptance*.

Defendant now attacks $\pi_1$ on its subargument for *reliable*.

$\delta_1$:
(7) $\Rightarrow$ *lied before*, (8) *lied before* $\Rightarrow \neg$ *reliable*,
---
so (9) $\neg$ *reliable*.

As argued in Section 3, this reply should not shift the burden of proof. Indeed, given the proof burdens, $\delta_1$ has the opponent role: by condition 2(b)i of Definition 4.4 its dialectical role is the opposite of that of $\pi_1$'s subargument for *reliable*, and by condition 2(b)ii that argument inherits its role from its superargument for *offer* $\wedge$ *acceptance*, which has the proponent role by condition 2a. So it suffices if $\delta_1$ simply defeats $\pi_1$. Furthermore, after moving $\delta_1$ the proof burdens have not changed.

However, suppose now that defendant, instead of claiming that the witnesses are unreliable, claims that there is an exception because of her insanity, and suppose that plaintiff challenges this exception. Then the law requires that after $\pi_1$ the judge assigns the burden of proving $Exc5$ to defendant:

$Burdens_{\pi_1}(\pi) = \{contract, offer \wedge acceptance\}$
$Burdens_{\pi_1}(\delta) = \{Exc5\}$

Defendant meets her burden of proof with the following argument:

$\delta_1''$:
(13) $\Rightarrow$ *court-doc*, (14) *declares-insane*,
(15) *court-doc* $\wedge$ *declares-insane* $\Rightarrow$ *insane*,
---
so (10) *insane*.
(10') *insane* $\Rightarrow Exc5$,
---
so (11) $Exc5$.

Because of the new proof burdens, $\delta_1''$ has the proponent role by condition 2a of Definition 4.4, so it must strictly defeat $\pi_1$.

Let us finally see how the burden of proof can switch back to plaintiff. Suppose that after defendant moves $\delta_1''$, plaintiff challenges the authenticity of the court's document. Then the judge will assign the burden of proof to him. Furthermore, since *court-doc* is conclusive evidence of *insane*, the judge will remove $Exc5$ from defendant's burdens.

$Burdens_{\pi_1,\delta_1''}(\pi) = \{contract, offer \wedge acceptance, \neg\ court\text{-}doc\ \}$
$Burdens_{\pi_1,\delta_1''}(\delta) = \emptyset$

Plaintiff attempts to fulfil his new proof burden with the following argument:

$\pi_2$:
(16) $\Rightarrow$ *incorrect-stamp*, (17) *incorrect-stamp* $\Rightarrow \neg$ *court-doc*,
---
so (18) $\neg$ *court-doc*.

According to the proof burdens at this point, $\pi_2$ has the proponent role by condition 2a of Definition 4.4 and must therefore strictly defeat $\delta_1''$.

Next I apply the new dialogue game to the last example of Section 3, also formalised in the system of [23]. Suppose that the legal procedure starts with plaintiff's claim for compensation because defendant damaged his car, and that defendant challenges both plaintiff's ownership and the claim that she damaged plaintiff's car. Then at the start of the dialogue we have the following allocation of the burden of proof.

$Burdens_\emptyset(\pi) = \{owner, damaged, compensation\}$
$Burdens_\emptyset(\delta) = \emptyset$

Plaintiff then provides evidence for *owner* by pointing at his possession of the car, and provides evidence for *damaged* in the form of a witness who saw defendant hitting the car with her bicycle.

$\pi_1$:
$\Rightarrow$ *possession*, *possession* $\Rightarrow$ *owner*, so *owner*.
$\Rightarrow$ *witness*, *witness* $\Rightarrow$ *damaged*, so *damaged*.
---
*owner* $\wedge$ *damaged* $\Rightarrow$ *compensation*,
---
so *compensation*

Suppose that after plaintiff has moved this argument, defendant still challenges *ownership*. Then the judge will change the allocation of the burden of proof as follows:

$$\begin{aligned} Burdens_{\pi_1}(\pi) = &\quad \{damaged, compensation\} \\ Burdens_{\pi_1}(\delta) = &\quad \{\neg owner\} \end{aligned}$$

*owner* is removed from plaintiff's burdens and the opposite is added to defendant's burdens, because of the legal rule that possession provides conclusive evidence of the claimed ownership.

As explained above, it now matters at which point defendant directs her attack. If she attacks $\pi_1$ with an argument for $\neg$*owner*, then by condition 2a of Definition 4.4, she must strictly defeat $\pi_1$, since $\neg$*owner* must at this stage be proven by defendant. However, if she attacks $\pi_1$ with an argument for $\neg$*damaged*, then condition 2a does not apply and we must look at the role of $\delta_1$'s defeat target in $\pi_1$. This is $\pi_1$'s subargument for *damaged*. By condition 2a of Definition 4.4 it has the proponent role because its conclusion must be proven by plaintiff; therefore defendant's counterargument has the opponent role by condition 2(b)i, so simple defeat suffices for defendant. Finally, what happens if defendant attacks $\pi_1$ with an argument for $\neg$*witness*? Again we must identify its defeat target, which now is $\pi_1$'s subargument for *witness*. To determine its role, we must now apply condition 2(b)ii and let it inherit the role of its smallest superargument, the argument for *damaged*. As just explained, this has the proponent role, so defendant's counterargument has the opponent role by condition 2(b)i, which means that simple defeat suffices.

To see another subtlety, assume now that after $\pi_1$ defendant challenges *possession* instead of *damaged*. Then *possession* is added to plaintiff's burdens because of the general rule that a party who states evidence, has the burden of proving it. So even though possession is, once proven, conclusive evidence for ownership, it must first itself be proven.

Finally, I apply the above model to the following legal considerations. It might be argued that, as a matter of procedural law, even if an argument is moved in the opponent role, its factual basis must always be proven. So, for instance, in $\delta_1$ of the contract example, defendant would have the burden of proving its factual basis *lied before* even though she does not have to prove its conclusion $\neg$*reliable*. Otherwise, defendant could simply say 'your witnesses lied before', after which plaintiff would have to prove that his witnesses never lied before, which seems unfair.

Let us see how this view can be expressed in our model. A straightforward way is to let the *Burdens* function always allocate the burden of proving the factual basis of an argument to its mover (apart from perhaps certain presumptions, of which the burden to prove falsity can be assigned to the other player). This solution is made possible by the fact that different parts of an argument can have different dialectical roles. Another way is to include this view in the 'internal strength' conditions on arguments. For instance, an argument could be ruled inadmissible if its factual basis does not have some initial degree of plausibility. However, as

said above, this aspect of reasoning with burden of proof falls outside the scope of the present investigations.

# 6. Discussion of other approaches

Let us now compare our model to the other approaches mentioned in the introduction.

## 6.1. Relation with logics for defeasible argumentation

To start with, we must answer the problem statement concerning the suitability of 'declarative' nonmonotonic logics. As explained above, it suffices to look at logics for defeasible argumentation. These systems have a well-studied declarative semantics. However, in this paper I have introduced a procedural notion into the dialectical proof theory, viz. an explicit allocation of burden of proof, which can make the dialectical roles switch and which, moreover, can itself change during a dispute. Does that make the argument-based semantics inapplicable, or is there still a link? A link would exist if we could prove that each time when plaintiff has won a dialogue with burden of proof, his main claim is justified on the basis of the arguments and defeat relations used in the dialogue. This would make insights and results from argument-based semantics available for our extended argument game.

However, it is easy to find a counterexample. Suppose $\pi$ moves $A$, $\delta$ becomes proponent because of a shift of the burden of proof and accordingly strictly defeats $A$ with $B$, after which $\pi$ (now opponent) simply defeats $B$ with $C$ and the dialogue terminates. The argumentation theory $AT$ constructed during this dialogue consists of the arguments $A, B$ and $C$ and the defeat relations '$B$ defeats $A$', '$C$ defeats $B$' and '$B$ defeats $C$'. According to our new argument game (Definitions 4.3, 4.4, 4.1 and 2.2) $\pi$ is the winner. However, according to the old argument game without burden of proof (Definitions 2.1 and 2.2) $A$ is not justified on the basis of $AT$: to make $A$ justified, $C$ should strictly defeat $B$.

This being so, I have not proven that a 'declarative' semantics for our new game is impossible. Nevertheless, I believe that the procedural notions of our analysis are so essential that finding a natural declarative semantics will be hard. And this gives reason to believe that a purely declarative modelling reasoning under burden of proof is insufficient.

## 6.2. Procedural AI & Law models

We must also evaluate the approaches in AI & Law that combine MacKenzie-style dialogue systems with a nonmonotonic logic. The first system of this kind, Gordon's *Pleadings Game* [7, 8], does not allow for shifts of the burden of proof. This is different in the models of [11, 3, 13]. However, they are still too rigid, since they make every counterargument induce a switch in dialectical role, while above we have seen that whether this happens, depends on the allocation of burden of proof.

## 6.3. Freeman & Farley's DART system

Finally, I discuss two models where a protocol for the exchange of counterarguments is augmented with an allocation of proof burdens.

Freeman & Farley [6] incorporate various levels of proof in an implemented protocol for dispute. The initial claim of a dispute can have one of five levels of proof, ranging from a 'scintilla of evidence' (which in present terms is a defensible argument), via 'dialectical validity' (a justified argument) to even stronger notions. Each level of proof induces a different protocol. For instance, for a scintilla of evidence, all counterarguments of the defendant must be strictly defeating, while the arguments of the plaintiff can be merely defeating. For dialectical validity these rules are reversed (which essentially results in the above-used proof theory for justified arguments). Although this proposal is very interesting, it has two limitations: it does not allow for distribution of the burden of proof over both parties and not for recursive allocations of burdens of proof.

### 6.4. The ZENO argumentation framework

Gordon & Karaçapilidis [9] have incorporated variants of Freeman & Farley's notions in their 'ZENO argumentation framework'. This is the part of the ZENO argument mediation system that maintains a 'dialectical graph' of the issues, the positions with respect to these issues, and the arguments pro and con these positions that have been advanced in a discussion, including positions and arguments about the strength of other arguments. Arguments are links between positions.

Part of the framework is a status assignment to positions: each position is assigned 'in' or 'out' depending on two factors: the required level of proof for the position, and the relative strengths of the arguments pro and con the position that themselves have antecedents that are 'in' (below called 'in' arguments). For instance, a position with level 'scintilla of evidence' is in iff at least one argument pro is 'in' (here they deviate from Freeman & Farley). And a position with level 'preponderance of evidence' is in iff the joint pro arguments that are 'in' outweigh the joint con arguments that are 'in'.

Since levels of proof can be assigned to arbitrary positions instead of only to the initial claim of a dispute, Gordon & Karaçapilidis overcome both limitations of Freeman & Farley's proposal. However, the proof levels are not made relative to a stage in a dispute. Still, Gordon & Karaçapilidis' proposal comes the closest to the present study, which can partly be seen as a generalisation and logical formalisation of their approach.

Finally, for present purposes it was not necessary to make the more fine-grained distinctions between levels of proof made by Freeman & Farley and used by Gordon & Karaçapilidis. However, it seems relatively easy to add these distinctions to the present model; I leave this for future research.

## 7. Conclusion

Concluding, I have given the following answer to the problem statement. Reasoning with burden of proof cannot be completely modelled in logics for defeasible argumentation (nor in any other nonmonotonic logic). Procedural notions are also needed, viz. those of dialectical roles, and an explicit allocation of burden of proof, which both can change during a dispute. These notions induce a new argument game, which has no clear correspondence with declarative argument-based semantics.

For logicians it is perhaps disappointing that, even if the new dialogue rules are clearly inspired by an argument-based semantics, there is no clear correspondence between the outcome of a dialogue with burden of proof and this semantics. However, for others this will count as support for the view that the semantics of (legal) defeasible reasoning is essentially procedural. At least, this article has provided ammunition for the 'procedural' side in the controversy on modelling defeasibility in law.

If a natural declarative semantics for our dialogue game is indeed impossible, then the question arises whether there are other standards to which the game can be measured. Loui [15] speaks of investigating the 'fairness' and 'effectiveness' properties of disputational protocols. This is an important issue for future research.

With respect to models of burden of proof, a main research topic is to extend the above dialogue game to a full model of legal dispute. One way is to embed the game in a MacKenzie-style dialogue system for making, challenging and retracting claims. See [20] for a first attempt to formalise this idea. Among other things, this approach requires that the set of constructible arguments (i.e., the argumentation theory) can change during the dispute. This introduces some technical problems, which are studied in [22]. Furthermore, a third player must be added, viz. a judge or referee, who assigns the burdens of proof, and who assesses the strength of the adduced arguments. See [21] for a first proposal in the setting of [20]. It is also necessary to allow for debates about the burden of proof, since this is itself a matter of law and therefore a subject of legal reasoning. This is analogous to allowing for debates about the strength of conflicting arguments. Several of the above-mentioned AI & Law systems already go some way in addressing these issues, but do not yet provide a system that addresses all aspects of reasoning with burden of proof.

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