Burden of Proof in Legal Argumentation

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in

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ABSTRACT

We present a computational model of dialectical argumentation that could serve as a basis for studying elements of legal reasoning. Argumentation is well-suited to decisionmaking in the legal domain, where knowledge is incomplete, uncertain, and inconsistent. We model an argument both as information structure, i.e., argument units connecting claims with supporting data, and as dialectical process, i.e., an alternating series of moves made by opposing sides. Inspired by the legal domain, our model includes burden of proof as a key element, indicating the level of support that must be achieved by a particular side to an argument. Burden of proof acts as a move filter and termination criterion during argumentation and determines the eventual winner. We demonstrate our model by considering two examples that have been discussed previously in the artificial intelligence and legal reasoning literature.

INTRODUCTION

As the artificial intelligence (AI) and legal reasoning communities are well aware, most decisions are reached against a background of incomplete, uncertain, and inconsistent knowledge (i.e., weak theory domains; Porter, et. al., 1990). The most widely used AI methods for reasoning under uncertainty either rely on an absence of outright contradictions (e.g., probabilistic reasoning; Pearl, 1987) or are unable to support motivated decision-making in the face of inconsistent information (e.g., default reasoning; Ginsberg, 1987).

Both solutions put the problem of deciding what to believe outside their respective domains of discourse. Choosing the proposition with highest probability or randomly choosing one of a set of consistent extensions are most often proposed as simplistic decision procedures. The correct propagation of probabilities and expansion of consistent extensions constitute the primary concerns of these theoretical approaches.

The legal domain, however, is concerned primarily with decisionmaking under difficult circumstances. Thus, an adequate theory of legal reasoning must provide a sound basis for choosing what to believe, e.g., guilt or liability. The practice of legal reasoning suggests a method for reasoning in weak theory domains that permits conclusions to be drawn relative to available evidence and perceived risks. Argumentation, with its emphasis on both supporting and refuting claims under situations of uncertainty and inconsistency, is well suited to serve as a framework for a practical definition of proof and proof procedure (Pollock 1992, 1994). Burden of proof introduces a mechanism for determining the outcome of an argument, allocating costs and risks in the face of inevitable uncertainty.

We present a computational model of dialectical argument. Our model comprises both argument as supporting explanation and argument as dialectical process. As an explanation structure, argument consists of argument units connecting claims with supporting data. As dialectical process, an argument consists of an alternating series of moves made by opposing sides. Inspired by legal reasoning, our model of argument incorporates the notion of burden of proof, roughly defined as what level of support must be achieved by which side of an argument. Burden of proof acts as a move filter and termination criterion during argumentation. We will provide operational definitions for several burden of proof levels that are derived from those used in legal settings. Argumentation moves, coupled with burden of proof requirements, will provide us with means to make decisions that are skeptical, credulous, or located appropriately between these two extremes.

In the following, we describe our model of argumentation and operational definition of burden of proof. We then demonstrate the model by considering two examples previously discussed in the AI and legal reasoning literature, illustrating the effects that different burdens of proof can have on argument process and outcome. We conclude with a discussion of related research and directions for future work.

MODELING ARGUMENT STRUCTURE

The representation of an argument as a structured entity and as a dialectical process are crucial elements of our theory. For argument as supporting explanations, we create argument structures that serve to organize relevant, available, and plausible support for a claim and its negation. We represent these argument structures in a form derived from that described in The Uses of Argument (Toulmin, 1958). An argument comprises *data* (i.e., input evidence, grounds) supporting or refuting a *claim*. The connection between data and claim or the authorization for moving from data to claim is called a *warrant*. Data and warrant may not be enough to establish a claim conclusively; a claim has a *qualification*. Furthermore, any claim is subject to *rebuttals*, i.e., arguments supporting its negation. All claims, including input data, must be supported, i.e., have *backing*. We define two types of backing: *atomic*, for information from outside the immediate realm of the argument (Horner, 1988) and *tau* ("Toulmin argument unit"), where the claim is supported by data through application of a warrant. Most input claims have atomic backing while most conclusions of an argument have tau backing. A single claim may have multiple backings.

A warrant is a rule-like piece of knowledge, having *antecedent* and *consequent* aspects. The antecedent and consequent fields consist of one or more propositional clauses. Multiple clauses in either the antecedent or consequent are taken to represent conjunctive elements. In addition, a warrant has two type fields. The *wtype1* field classifies the relationship between the antecedent and consequent as explanatory (ex) or sign (si), as in (Freeley, 1990). An example of an explanatory relationship is a causal link, where knowledge of the antecedent "explains" knowledge of the consequent, e.g., "where there's smoke (as the consequent), there's fire." A sign relationship represents a correlational link between antecedent and consequent, e.g., "Summer weekends are generally rainy."

The *wtype2* field of a warrant represents the strength with which its consequent can be drawn from its antecedent. The va*lues we use are sufficient (s), default (df), and evidential* (ev). A sufficient warrant is meant to represent conclusive relationships, such as definitions. Default and evidential warrants are meant to represent levels of uncertain knowledge, with default indicating relationships that are usually (almost always) the case (e.g., "birds fly") and evidential referring to less certain, but still likely, links (e.g., "persons who live in Bermuda are more often British subjects").

TABLE 1. Reasoning Steps

warrant	data	conclusion	step
p -> q	p	q	(MP)
p -> q	not q	not p	(MT)
p -> q	q	p	(ABD)
p -> q	not p	not q	(ABC)

Given a warrant with antecedent p and consequent q, we define allowable reasoning steps in Table 1. The latter two reasoning steps are fallacies in the context of deductive reasoning (asserting the consequent and denying the antecedent, respectively). However, they can be appropriate and are are often applied in reasoning contexts where knowledge is incomplete or uncertain, as in the legal domain. Polya (1968) and Rescher (1976) discuss such reasoning as "patterns of plausible inference".

When deductive and plausible reasoning types are present in the same system, care must be taken to avoid inappropriate reasoning combinations (Pearl, 1987). For example, if the reasoner knows that "rain causes wet-grass" and "sprinkler-on causes wet-grass", an unrestricted combination of modus ponens and direct abductive reasoning would allow the reasoner to derive support for the claim "sprinkler-on" from the input data "rain". To block the generation of such unacceptable arguments, MP/ABD combinations are not permitted across two explanatory warrants.

Qualifications are used to capture the level of support for claims, reached as a result of arguments based upon uncertain knowledge and plausible reasoning steps. Presently, we use the following qualifications: valid(!), strong (!-), credible (+), weak(-), and unknown (?). The first four are ranked in order of decreasing level of support, while the last indicates no support in the current argument. The qualification on a claim is that associated with its strongest supporting argument. The qualification afforded a claim from a tau backing is the least of the qualifications associated with the warrant application, being qualifications on the data support, on the warrant itself, and from the link. The link qualification is derived from the warrant type and reasoning step applied, as presented in Table 2. We capture the plausible nature of most modus tollens reasoning by propagating only a weak qualification when not involving a sufficient warrant. The weakest link approach to propagating support across warrants and its appropriateness for plausible reasoning has been discussed (Pollock, 1992; Rescher, 1976).

We represent all claims in an argument structure only in their positive (i.e., unnegated) forms. Thus, each claim in the structure has two associated qualifications, summarizing the strength of support for the claim and for its negation.

TABLE 2. Link Qualifications

warrant type	reasoning step	link qualification
$\rightarrow_s$	MP, MT	valid
$\rightarrow_s$	ABD, ABC	weak
$\rightarrow_{df}$	MP	strong
$\rightarrow_{df}$	MT, ABD, ABC	weak
$\rightarrow_{ev}$	MP	credible
$\rightarrow_{ev}$	MT, ABD, ABC	weak

MODELING ARGUMENT PROCESS

A structural model does not capture the procedural, sequential character of dialectal argumentation. Dialectical argumentation results in the intertwining, over time, of argument structures generated by *Side-1* in support of a claim and by *Side-2* in support of its negation.

An argument begins with Side-1 attempting to find support for the input claim. Given a claim, search for support proceeds from the input claim toward input data, using warrants as intermediate steps. The process has been completed when all (sub)claims are supported by propositions in the input. A new tau structure is generated for each warrant applied; the qualification and backing fields of the claims are updated to reflect the new support. If no initial support can be found, the argument ends with a loss for Side-1; all burdens of proof require that at least one supportive argument for an input claim be found.

If Side-1 is able to find support for the claim, control passes to Side-2, which tries to refute the argument for claim(s) established by Side-1. We distinguish two types of refutation actions: (a) rebutting and (b) undercutting, as derived from Pollock (1987). *Rebutting* finds new arguments directly supporting the negation of a claim. *Undercutting* is accomplished by finding weaknesses in purported support for a claim, questioning the sufficiency of the input support or tau fields, i.e., by rebutting subclaims. Argument moves implementing the various tasks of dialectical argumentation are described in Table 3.

If an undercutting move is successful, it may result in a change to the qualification of a claim or the withdrawal of a supporting argument. In the latter case, such moves are said to be *defeating* arguments and are indicated by the * entries in Table 3. These moves are in response to an argument for which an exception is found (i.e., a more specific counterargument is found) or to a weak argument made by the other side, i.e., those based on plausible, not deductive, reasoning steps. Note that arguments defeat steps in other arguments, not the claim supported by that argument. Rebutting arguments that merely find alternative, unrelated arguments for the negation of a claim only serve to make the original conclusion controversial, changing its qualification. Whether this is a sufficient outcome for a given side of an argument will depend on the burden of proof.

For example, suppose we make the default argument that a penguin flies because it is a bird. An argument based on an evidential warrant stating that most things whose names start with the letter "p" don't fly would only serve to make the claim controversial. In fact, the orginal claim would still have stronger support. However, our

TABLE 3. Dialectical Argument Moves

ARG TASKS	MOVES	GIVEN	SHOW	defeat
support C	(a) support	C	X->C ^ X	
			C->X ^ X	
			~C->X ^ ~X	
			X ->~C ^ ~X	
refute C				
undercut C	(b) invalid	X->C	~X	
	antecedent	^X		
	(c) exception	X->C	X^Y->~C	*
		^X	^Y	
	(d) inapplicable	X->~C	Y->~C	*
	evidence	^~X	^Y	
	(e) unneeded	C->X	Y->X	*
	explanation	^X	^Y	
rebut C	(f) reductio ad	C	C-->Z	
	absurdum		^~Z	
	(g) rival	C	X->~C	
	support		^X	
	(h) missing	C	X->C	
	support		^~X	
	(i) rival	C	~C->X	
	implication		^X	

initial argument could be defeated by the argument that penguins are an exceptional sort of bird that does not fly. This would leave our claim that penguins fly with no positive support and a strong argument against.

When a side is in control of the argument process, it must select which argument move to apply next from a set of possible moves. Heuristics that serve to order argument moves for selection are meant to reflect two goals: generate the strongest arguments possible for the active side and generate coherent arguments that are responsive to those put forward by the other side. As such, agument moves are ordered, as follows: (a) valid reasoning steps are preferred over plausible steps; (b) moves that are defeating are preferred over moves that only make a claim controversial; (c) moves that attack a supporting argument closer to the overall claim are preferred; and (d) undercutting moves are preferred over rebutting moves. Warrants are also ordered according to the following criteria: (a) specific warrants (i.e., those with more antecedents) are preferred over more general warrants; (b) stronger warrant types are preferred; and (c) warrants for which the antecedent currently has no known contradictory support are preferred.

These ordering heuristics anticipate moves that the other side may use in trying to refute a claim. Strong reasoning steps are more difficult to defeat; those closer to the root claim leave fewer opportunities for alternative support; defeating arguments eliminate controversial elements; weaker reasoning types allow more opportunities for defeating refutations. Controversial or negated data can be used to support a claim weakly at best.

This completes an overview of the basic elements of our model of dialectical argumentation. Given a set of warrants, some input data, a claim, and a burden of proof, our system proceeds to generate a dialectical argument, both structure and process. Control switches from side to side as check conditions, i.e., sufficient refutations for a given burden of proof, are realized. Deciding which moves are sufficient to generate a check condition for a particular side, when an argument process is complete, and who wins, all depend upon a given burden of proof.

BURDEN OF PROOF

Now we turn our attention to the definition of burden of proof and discuss its impact on argument generation and outcome decision. There are two elements to the notion of burden of proof: as we will define it: (1) which side of the argument bears the burden; (2) what level of support is required of that side. As we consider only two sides to an argument (for and against the input claim), we assume that Side-1 always bears the burden of proof for the input claim, which might be stated as the negation of a proposition.

One context in which the notion of burden of proof has been defined historically and applied formally is the legal domain. Different burden of proofs are mandated at different stages of the legal process and for different types of legal action. For example, the arguments required to indict someone need not be as convincing as those needed to convict; the arguments needed to convict in one type of trial need not be as strong as those needed to convict in another type of trial. The higher the cost of being wrong, the more strict are the requirements that should be imposed.

A *defendable argument* is one that cannot be defeated with the given warrants and input data. This has been called a *plausible argument* (Sartor, 1993). We define the following levels of support:

- *scintilla of evidence (se)*
  at least one weak, defendable argument
- *preponderance of the evidence (pe)*
  at least one weak, defendable argument
  outweigh the other side's arguments
- *dialectical validity (dv)*
  at least one credible, defendable argument
  defeat all of the other side's arguments
- *beyond a reasonable doubt (brd)*
  at least one strong, defendable argument
  defeat all of the other side's arguments
- *beyond a doubt (bd)*
  at least one valid, defendable argument
  defeat all of the other side's arguments

Burden of proof plays several roles in the process of argumentation: (i) as basis for deciding relevance of particular argument moves; (ii) as basis for deciding sufficiency of a side's move (i.e., whether a check condition has been realized); (iii) as a basis for declaring an argument over; and (iv) as a basis for determining the outcome (i.e., decision or winner) of an argument.

For example, if we have imposed a burden of proof of dialectical validity and Side-2 has presented an argument refuting Side-1's claim, Side-1 cannot merely find another argument supporting the input claim; Side-1 must defeat the refutation or concede the argument. However, if the burden of proof were only preponderance of the evidence, then another argument in favor of the claim by Side-1 could be sufficient to outweigh Side-2's rebuttal. For a burden of proof of beyond a reasonable doubt, Side-1 must find an initial argument based upon valid application of a sufficient or default warrants; otherwise, it must concede defeat without Side-2 even needing to make a move, as strong support must be found for the input claim under this burden of proof.

LEGAL REASONING EXAMPLES

The source of inspiration for including burden of proof in our model of argumentation comes from the legal domain. Western legal process has long relied on this notion as a means for making decisions in uncertain, confusing, or contradictory contexts. We demonstrate our model of argument and burden of proof by considering two examples that have previously appeared in the AI and legal reasoning literature.

The first problem, which has been used to demonstrate application of default and rule-based reasoning in a legal context, is from (Prakken, 1991). The knowledge from the problem is represented by the following warrants and data:

```
(w1 ((loose bricks)) --> ex df
     ((maintenance deficiency)) (!? GIVEN))
(w2 ((maintenance deficiency)) --> ex df
     ((landlord responsible)) (!? GIVEN))
(w3 ((landlord responsible))--> ex s
     ((not (tenant responsible))) (!? GIVEN))
(w4 ((loose bricks)(near road)) --> ex df
     ((danger)) (!? GIVEN))
(w5 ((danger)) --> ex df
     ((tenant responsible)) (!? GIVEN))
(w6 ((loose bricks)(near road)(seldom used))
       --> ex df ((not (danger))) (!? GIVEN))

(d1 (loose bricks) (!? GIVEN))
(d2 (near road) (!? GIVEN))
(d3 (seldom used) (!? GIVEN))
(claim (landlord responsible) (?? NIL))
```

That is, loose bricks in a rental unit are usually a maintenance deficiency, and taking care of maintenance deficiencies is usually the responsibility of the landlord, not the tenant. However, if the loose bricks are near a road, they constitute a danger; the tenant, not the landlord, is usually responsible for any danger. However, loose bricks near a road that is seldom used is usually considered not be considered a danger. In this case, there were loose bricks near a road, and the road was seldom used. Who's responsible?

Side-1 is able to find strong support for the input claim (landlord responsible) through MP application of warrants w1 and w2 based on input data d1. However, Side-2 can refute this argument by finding an argument for the negation of the input claim, showing that loose bricks near a road constitute a danger, for which the landlord is not responsible (i.e., using warrants w4 and w5 and an MT application of the sufficient warrant W3). But this argument can be undercut and defeated by Side-1, which can show that the data d3 in the current situation matches the conditions of warrant w6, a more specific exception to the w2 default rule as to danger. Warrant w6 can be used to show that loose bricks near a road that is seldom used do not constitute a danger after all. Side-2's argument for there being danger is thereby defeated, reinstating the original argument that the landlord is responsible as the dominant argument. At this point, Side-2 can generate no more counterarguments; Side-1, having defended a strong argument for the landlord responsibility, will win this argument for any proof level up to and including beyond a reasonable doubt.

Note that if the burden of proof on Side-1 had been scintilla of evidence, Side-2 would not have attempted its one refutation; even if successful, it would not have been strong enough to defeat Side-1's argument outright, as would have been needed for Side-2 to win the argument at this proof level. On the other hand, if the burden of proof on Side-1 had been beyond a doubt, Side-1 would have conceded the argument immediately, as there are no sufficient warrants available to support the input claim with valid qualification.

If we consider the counterclaim, i.e., (not (landlord responsible)), as the input claim, Side-1 could generate a supporting argument based on warrants w4, w5, and w3 as above, with input data d1 and d2. But, as we have seen, w4 can be defeated by w6. Side-1 would have no other argument for (not (landlord responsible)) and would have to concede. We see that the claim (not (landlord responsible)) cannot be established with even a scintilla of evidence.

Suppose we consider that the input evidence about the road being seldom used is only hearsay and at best can be given a qualification of credible. This would change the input now to include (d1 (seldom used) (+? GIVEN)). In this case, the undercutting argument by Side-1 using warrant w6 would not be considered a defeating argument; it is of lower qualification than the argument it is attacking. However, it still serves to make the claim (danger) controversial by providing support for its negation; this would weaken Side-2's counterargument, leaving the input claim with the qualification (!- +). Side-1 has no way of outright defeating Side-2's counterargument. Thus, in this case, Side-1 can only win arguments up through preponderance of the evidence. With this input, the counterclaim (not (landlord responsible)) now could win with a burden of proof of scintilla of evidence, as well; Side-1 can only make its initial argument at most controversial.

In the our second example, adapted from (Marshall, 1989), we show how the argument model deals straightforwardly with inconsistent information and no defeating exception. We consider the following, initial knowledge regarding the case:

```
(w1 ((burglar)) --> ex s ((felon)) (!? GIVEN))
(w2 ((fleeing suspect) (felon)) --> ex df
      ((deadly force reasonable)) (!? GIVEN))
(w3 ((not (apprehension possible))) --> ex df
      ((deadly force reasonable)) (!? GIVEN))
(w4 ((two officers present)) --> ex df
      ((apprehension possible)) (!? GIVEN))

(d1 (burglar) (!? GIVEN))
(d2 (fleeing suspect) (!? GIVEN))
(d3 (not (armed suspect)) (!? GIVEN))
(d4 (private residence) (!? GIVEN))
(d5 (unoccupied residence) (!? GIVEN))
(d6 (< ten dollars taken) (!? GIVEN))
(d7 (two officers present) (!? GIVEN))
(claim (deadly force is reasonable) (?? NIL))
```

According to the warrants given, a burglar is, by definition, a felon. When pursuing a fleeing felon or when apprehension is not possible, the use of deadly force is reasonable. When two officers are present, non-violent apprehension is usually possible. In the given situation, an unarmed burglar is fleeing from an unoccupied, private residence, from which less than ten dollars has been stolen. There are at least two officers available to stop the burglar. Is deadly force reasonable in this case?

Side-1 is able to make a strong argument for the input claim (deadly force is reasonable) based on MP applications of warrants w1 and w2 with input data d1 and d2. Side-2 can respond only with an argument based on MP application of w4 followed by plausible, ABC application of warrant w3, leading only to weak support for the counterclaim. Under all burdens of proof, Side-2 would concede the argument prior to generating the above argument, as the burden of proof would filter the moves leading to its generation.

Warrant w2 is meant to reflect the import of a Tenessee law intending to discourage felons from fleeing the scene of a crime. The law gives police free reign to use deadly weapons as means to stop them. The U.S. Supreme Court felt the rule was open to abuse and contrary to the intent of federal statutes requiring some indication of threat of danger to property, the public, or the police prior to allowing the use of deadly force. Suppose we now change w2 to w2' to reflect this pespective and add w5 as one of several, possible supporting warrants, as follows:

```
(w2' ((dangerous suspect) (fleeing suspect)
        (felon)) --> ex df
      ((deadly force reasonable)) (!? GIVEN))
(w5 ((armed suspect)) --> ex ev
        ((dangerous suspect)) (!? GIVEN))
```

In this case, Side-1 can not even generate an argument in favor of the input claim and thus can win no argument at any proof level. If the claim is changed to the counterclaim, Side-1 then has two weak arguments. One is based on ABC application of warrant w3 as discussed above, and the other is based on ABC applications of both w5 and then w2', i.e., (not (armed)) leads to (not (dangerous)), which supports (not (deadly force reasonable)). Note that support for the negation of only one proposition of a conjunctive condition allows ABC application of the warrant. Thus, the counterclaim of deadly force not being reasonable can win scintilla of evidence arguments.

This argument setting is obviously highly controversial; neither side can generate strong arguments in its favor. This leaves suggests the opportunity for introduction of new warrants providing arguments in support of either side. The use of dynamic sets of warrants, where new warrants can be introduced (as is often done during legal arguments), is an element of argumentation yet to be addressed by our model.

RELATED RESEARCH

There has been increasing interest in formal models of argumentation in both the artificial intelligence and legal reasoning communities. We have referred to some of that work above.

The notion of interargument defeat has been addressed by several recent efforts. The idea of more specific arguments viewed as exceptions, and thus defeaters, has been pursued by Poole

(Poole, 1985) and adopted by others (Prakken, 1991, Loui, et.al., 1993). We continue that notion, inheriting this general approach to defeating arguments. Since we allow unsound, weak reasoning steps to be applied, we have other opportunities for defeating arguments. Any counterargument based solely on MP reasoning steps, regardless of qualification on the links, is seen as sufficient to defeat an unsound, weak argument. As such, a weak arguments is fragile, but may prove to be crucial if left unanswered.

In other related research, the work of Sartor (Sartor, 1993) comes closest to capturing our various notions of proof level. He defines a *plausible argument* to be one with no defeating counerargument. This would be an argument sufficient to win a scintilla of evidence argument for a particular claim. He then describes a *justifying argument* as a plausible argument for a claim and no plausible argument for its counterclaim or negation. This is what we require of a dialectically valid argument. Prakken introduces related concepts as well (Prakken, 1991). Neither explore the application of burdsen of proof an different proof levels as an element of control for generating coherent, dialectical argument processes. They assume all arguments are generated and then uses these relationships to prune these sets or contrast competing arguments.

CONCLUSION

We see that burden of proof is a particularly useful aspect of a computation model of argumentation as a basis for practical reasoning in the legal domain. Our model comprises both argument as supporting explanation and argument as dialectical process. It incorporates other features appropriate for reasoning in weak theory domains, including plausible inference and uncertainty representation. We demonstrate the application and impacts of different burden of proof levels in two simple, legal argument contexts.

Our model of dialectical argumentation has been implemented and evaluated on a significant number of classic reasoning problems in weak theory domains, including those discussed here. The model as implemented exhibits reasonable behavior when applied to these benchmark examples taken from formal argumentation and artificial intelligence research (Freeman, 1993). We hope our model can serve as a framework for further exploration of argumentation as a means for practical and legal reasoning.

We are investigating several extensions to the model, including addition of a new warrant type *case* that will incorporate elements of case-based reasoning. Such warrants would have facts of prior cases as antecedents, with conclusions representing case outcomes. A particular case may give rise to multiple warrants, representing various, differing interpretations of the reasoning or outcome of a case (Ashley, 1989). To reflect adequately the way cases are used in arguments, partial matching and matching by analogy on the structure of fact sets involved would have to be allowed (Branting, 1989). How this would interact with warrant qualifications and burden of proof to generate typical argument strategies involving cases (Rissland, 1985; Skalak and Rissland, 1993) poses further, interesting research questions.

As in the second example discussed above, where the federal law takes precedence over state statute, giving differing weights or preferences to warrants (beyond that of qualification) is another direction for exploration. This factor has been used by a number of recent researchers, who put explicit, hierarchical preferences on warrants (Loui et.al, 1993; Prakken, 1993; Sartor, 1993). Combining these new modelling capabilities with a generalized definition of burden of proof in a dialectical, process model of argumentation would significantly advance efforts toward an adequate model of legal argumentation and decisionmaking.

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