Introducing the Logic and Law Corner

TREVOR BENCH-CAPON, *Department of Computer Science, University of Liverpool, Liverpool, L69,7ZF, UK.*
E-mail: tbc@csc.liv.ac.uk

HENRY PRAKKEN, *Department of Information and Computing Sciences, Utrecht University, The Netherlands, and Faculty of Law, University of Groningen, The Netherlands.*
E-mail: henry@cs.uu.nl

Abstract
In this paper we introduce the *Logic and Law* corner of this journal. We will discuss a number of ways in which logic has been used in AI and Law, and give some of the key references to previous work on these topics. We will also list some important questions which we see as ready for further exploration. We encourage contributions on these, and other, Logic and Law issues.

1. Logic and law

The purpose of this paper is to provide an introduction for the *Logic and Law* corner of this journal. Law is of vital importance, touching the lives of all people. The effect of law also matters a great deal, and the costs of mistakes can be serious. In order to comply with the law it must be understood by those it affects, and to be accepted it must be explained in terms that are comprehensible by those to whom they are addressed. Moreover, the law must be applied in a way which is transparent and accountable. Clearly computer systems can assist with all these aspects, but they require clarity of meaning and soundness of reasoning: hence the importance of logic for law.

In the early days of the application of logic to the law there were some simplistic expectations: that it would be enough to represent the law as a logical theory and to deduce the consequences of that theory. This view proved too narrow, for the reasons we will discuss in this paper. We will identify some key uses of logic in law, by briefly describing some prominent historical work, mentioning some key papers reflecting the state of the art and finally pointing to some of the main current issues which we hope will be addressed by papers that will appear in this corner. We will see that the need to address problems arising from applying logic to the law has driven developments in logic and reasoning and has also provided a significant test of logical techniques in general. From a brief initial overview of the history of logic in AI and law we will identify three chief roles for logic, a shift in their relative importance, and an associated broadened conception of logic.

The original use of logic in law was for representation of law in a clear and unambiguous manner. In these approaches, reasoning was seen as simply deduction from the resulting formal representation. This conception, adopting a narrow, Fregean, view of logic, sees reasoning as following from representation: once the meaning of the concepts has been formalised, the notion of valid inference follows automatically,

so that the main task is to develop sound and complete proof procedures. In other words: representing the law comes first; the reasoning follows from it and can be done within a traditional conception of logic. This approach was popularised in [45], which showed the strengths of the approach by applying it to a piece of new legislation in which issues of interpretation were minimised, but the success here was not readily transferable to other areas.

Attempts to build on this work led to the realisation that many aspects of legal reasoning go beyond the semantics of traditional logical approaches. When a law is framed, the legislators are well aware that they cannot envisage all the circumstances in which it will be applied. Typically they will enunciate a general norm, capturing the essence of the proposed measure, and then qualify this with a series of exceptions. Furthermore they use abstract concepts, intended to be interpreted in the light of the concrete facts of the cases that are brought before the court. This leads to uncertainty and disagreement, in situations moreover, where there are inevitably conflicts of interest. Therefore, to apply to law, the logic must be robust in the face of exceptions, conflicting rules, vagueness, and open texture and recognise the possibility of rational disagreement.

Some of these features primarily led to innovations in approaches to reasoning, others made it necessary to consider context, procedure, interaction and other dynamic aspects. The need to handle these features has also led to a broader (non-Fregean) conception of logic. This is essentially a special case of a general development in logic. For instance, [15] speaks (in addition to a computational turn) of first a cognitive turn in logic, in which greater interest is paid how reasoning is actually practiced and then an interactive turn, in which the reasoning is considered in the context of the behaviour of intelligent agents engaged in social interaction, with meaning emerging from these communicative exchanges.

We will address these three aspects of logic and law in turn. Logic for representation will be discussed in section 2, logic for modelling reasoning in section 3, and logic for modelling interaction in section 4. Section 5 identifies some important topics for future exploration, and section 6 offers a brief conclusion.

2. Representation

This section will discuss several aspects of the use of logic to represent law.

A very early use of logic was to provide a systematic way of revealing syntactic ambiguities in legislation [4]. Legal drafters, for example often use “if” indiscriminately, sometimes expressing only a sufficient condition, but at other times expressing a necessary and sufficient condition. Often these variant readings will interact, giving rise to a very large number of possible interpretations of the text (e.g. [5]).

Many sentences in law express norms, and therefore contain terms like “may”, “must” and “shall”. Deontic logic attempts to provide formal tools for the clarification of the meaning of these terms, and so it is unsurprising that deontic logic has been used in

the analysis of law (e.g. [1], [29] and [24]). It became clear that an important aspect here is the normative positions and legal relations that follow from these norms ([25], [44] and [42]). Normative positions exhaustively specify how a particular action of a particular agent is regulated. For instance, our normative position with respect to writing this article is that we are permitted but not obliged to write it and permitted but not obliged not to write it. Legal relations express the normative expectations of one agent with respect to another and how the agents can change these. Contracts are an important source of legal relations and therefore the modelling of legal relations has especially been studied in the area of automated contract management (see e.g. [16]).

Since norms regulate behaviour and prescribe sanctions for those that violate them, notions of agency, responsibility, causation are required to articulate what it is to comply with and to violate norms. These notions have been widely discussed in philosophical logic and practical philosophy, but have received relatively little attention in AI and Law (but see [49]).

Time and change also have considerable importance in law. Law is subject to amendment, and so we must recognise the norms that are in force at a given time. Actions and events modify legal relations and normative positions, and so these must also be capable of dynamic assignment. Time is also important as it is frequently used as part of conditions in norms. There is some AI and Law work on time and change, applying the event calculus [23] or defeasible logic [20] but much more can be done. A good overview of the issues and possible approaches is given by [47].

Change in law can also be studied abstracting from time, as in belief revision. In fact, one of the papers that gave birth to belief revision, [2], applied the idea of belief revision to the legal problem of determining the result of derogations of norms. However, this work has had little follow up from others within logic and law.

A topic related to time and change is that of specifying legal and organisational procedures. The law often prescribes sequences of actions which must be followed to achieve a certain legal effect. For example, application for a benefit requires that the claimant and the adjudicator perform a series of actions in a prescribed order within certain time constraints for the claim to be effective. Other examples of legal procedures are complaint procedures, elections, audit procedures, decision-making procedures, and so on. Also, organisations often design their own procedures in order to comply with the law. (One can even think of the general procedures for court proceedings but since, as we will explain below, these are intimately linked with the notion of reasoning, we will discuss them in a separate section.) Formal specification of legal and compliance procedures has many practical applications but is so far a largely neglected topic in AI and Law, except for some initial work by, for instance, [31] on voting procedures, [19] on auction and negotiation procedures and [3] on verifying compliance procedures.

A first challenge for ‘traditional’ conceptions of logic is posed by several structural features of legal regulations [8]. These include the use of exceptions; the use of hierarchies of legislation to resolve conflicts between different regulations; cross references to other parts of legislation; deeming provisions (such as when a healthy but pregnant teacher is deemed to be ill when there is an outbreak of rubella in her

school, entitling her to claim sickness benefit); conditions under which the legislation is applicable; and conditions for the validity of particular norms. The first uses of non-monotonic logics in AI and Law were to address these features (see [38] for an overview).

However, it was soon realised that 'standard' nonmonotonic logics have limited applicability and this led to considerations that take us beyond representation and into reasoning (the cognitive turn). While some of the challenges thrown up by law can be met by adapting or extending the logic, others seem to require that the context and content be considered in order to reach resolution. Originally, use of nonmonotonic logics kept rules at the centre of attention. Despite the identification of several principles for resolving conflicts between rules (for example, preferring the most recent, the most specific or the hierarchically most important) these principles proved inadequate to provide a general means of conflict resolution. Such general principles often only apply to certain categories of rules (those just mentioned only apply to statutory regulations, although there are some analogous principles relating to case law, where decisions of higher courts may be binding on lower courts), they are defeasible themselves, and they may themselves conflict. More often, conflicts arise not from competing norms, but from the variety of ways in which they can be interpreted. As noted above, law contains terms intended to be closed by court decisions in the light of particular cases, and this has often led to conflicting interpretations. At the very least, this gives rise to a need to represent case law as a source of interpretations. However, simply representing the decisions made in precedent cases as a rule is not enough since a new case will rarely exactly match the precedent, so that techniques for handling conflicting rules fall short. Moreover decisions can typically be represented at a number of different levels of abstraction, making the precise formulation of such a rule controversial. This recognition contributed to the shift of focus from representation to an exploration of modes of reasoning, such as analogy, case-based reasoning and theory construction.

In the next section we will briefly recall some of the techniques which have been used in AI and Law in response to these problems.

3. Reasoning

The problems identified at the end of the last section led to several broader accounts of legal inference. Some remained within the spirit of 'standard' nonmonotonic logic. For instance, [17] and [36] modelled dialectical argumentation with rules, embedding standard techniques for handling exceptions and rule conflicts in inference procedures modelled as games. Hage and Verheij (e.g. [21]) developed reason-based logic, which puts the notion of *reasons* at the centre: reasoning is modelled as the construction and weighing of competing reasons, and rules are merely one source of reasons, which have to weighed against competing reasons. Reason-based logic also provides sophisticated accounts of what it means to apply a rule, and of the difference between legal rules and legal principles [46]. In all of this work one concern has been the modelling of reasoning *about* preference criteria, acknowledging the fact that reliable general conflict-resolution principles cannot be given.

Case Based Reasoning

As explained above, one often needs to look at decisions in individual cases to see how conflicts have been resolved in particular contexts with respect to the content of the conflicting norms. These decisions will tell us what considerations are relevant to given conflicts. In case-based reasoning one goes further and attempts to use particular cases to show how these considerations justify particular outcomes in these cases. As discussed above, the main challenge here is to cope with the fact that a new case rarely exactly matches a precedent. In AI and Law several influential computational models of case-based legal reasoning have been developed (see [40] for an overview) The logical formalisation of these models was addressed in e.g. [27], [28] and [37]. Initially, this work attempted to extend the dialectical procedures for rule-based reasoning to case-based reasoning. Later, these procedures were combined with models of practical reasoning and theory formation.

Practical and Teleological Reasoning

Some legal decisions involve the exercise of discretion: the arbiter can choose what the resolution shall be. Often there will be reasons presented on both sides of an argument, and it is the role of the judge to choose which should prevail. The choice, however, needs to be justified so that it can be seen as acceptable to higher courts, and perhaps to the public at large (see [13], Ch. 10). Justification of choices is the domain of practical reasoning. Examples of such reasoning can be found in AI and Law: in particular, attention has been paid to the justification of choices in terms of the underlying purpose of the law, or so as to achieve the most desirable consequences ([7], [22]).

Theory Formation

A long standing view of legal reasoning (e.g. [30]) is that it should be seen as constructing a theory to explain the decisions made in the past. This view was revived more recently by [9], which offered a detailed account of what constitutes a theory intended to explain a body of case law, and how such theories could be constructed from givens (facts, precedents). This approach has also been the subject of a number of computational experiments in [12] to assess the quality of legal theories constructed from a set of givens in US Trade Secrets law.

Reasoning about evidence

Most of what has been said above pertains to normative issues: to the classification of the facts of a case under legal concepts, to the interpretation of these concepts, and to the derivation of normative consequences from these classifications and interpretations. In fact, most AI and Law research takes the facts of the cases as givens. However, in the practice of law, cases are mostly about establishing the facts and therefore logic will not fully serve the law if it does not address the modelling of reasoning about evidence. At first sight it might be thought that this can be left to statistics and probability theory, but, for various reasons, there is a place for logic here. In legal cases the numbers required by statistics are often not available so that qualitative reasoning models must be used. Even when numbers are available, the statistical evidence can be criticised in many ways (e.g. were the data collected in a sound way, does the statistical model correctly model the problem, is the conclusion drawn from the statistics warranted) so that the use of statistical evidence must be embedded in more general models of legal argumentation.

There is some initial work on evidential reasoning in AI and Law. For instance, in [11] Bex et al. have formalised an argument-based approach by combining an argument-based nonmonotonic logic with the argument-scheme approach (see below), while in [32] Poole has illustrated how a scenario-based approach to reasoning about evidence can be modelled as abductive reasoning in his Theorist system. In [10] Bex et al try to combine the argument- and scenario-based approaches. However, much more remains to be done, especially on the integration with statistical methods.

We end with a brief discussion of two more general formal techniques that have been used in AI and Law to model legal reasoning.

Argument Schemes
Taking inspiration from work in informal logic such as [48], a number of the above problems have been addressed using argument schemes, e.g. [33]. Argument schemes are stereotypical patterns of reasoning, and can be more or less domain specific. Argument schemes establish a presumption in favour of their claim, which must be defended against a critique made using so-called critical questions that are characteristic of the particular scheme. An example of an argument scheme for evidential reasoning is *If a witness says that P then P.* Three critical questions of this scheme are: is the witness sincere, was the witness in the position to observe P and does the witness correctly remember it? An argument scheme for practical reasoning is *I want to achieve G, doing A will achieve G, so I should do A.* Among the critical questions associated with this scheme are: will doing A achieve G? are there better ways to achieve G? will doing A also have undesirable consequences?

In AI and Law explicit use of argument schemes has been made by e.g. [11] in the context of evidential reasoning and by e.g. [7] in the context of practical reasoning. Prakken [33] argues that much AI and Law work implicitly adopts the argument scheme approach.

Argumentation Frameworks
One development in logic and AI which has had considerable influence in law is the introduction of argumentation frameworks by Dung [14] His approach, originally intended as a unifying theory of nonmonotonic logic and logic programming, is entirely abstract, a framework comprising a set of arguments and a binary attack relation between them. The acceptability of an argument is then considered relative to a subset of arguments in the framework able to defend it against its attackers. In law this basic idea has been adapted in a number of ways. For instance, in [36] Prakken and Sartor have instantiated Dung's abstract approach by making the notions of argument and attack more structured and by showing how reasoning about the rule priorities that determine the attack relations can also be captured within the framework. Bench-Capon e.g. [7] has introduced the notion of the value promoted by the acceptance of an argument, which allows for a general distinction between attacks and successful attacks based on a preference ordering of these values, so as to express legal teleological reasoning.

4. Interaction

The need for legal reasoning mostly arises in the context of a conflict between different parties, decided within a prescribed legal procedure for conflict resolution. This means that legal reasoning typically takes the form of a dialogical exchange of arguments representing the alternative views, followed by a reasoned justification for adopting one of the views rather than the other. The conduct of the dispute will be regulated by procedures appropriate to the particular form of dispute, and the justification of the outcome will depend on these procedures having been followed.

An important insight here is that, given a set of facts and a body of law, the outcome may depend on the procedures that must be followed. This means that we cannot abstract the reasoning from the context of the dispute to identify the proper conclusions: it is intertwined with the procedures being followed (see also [26]). Several examples can be cited. It may be that the outcome in otherwise identical cases may depend on which party is assigned the burden of proof. It may be that the finding will be different if it is a civil proceedings rather than a criminal proceedings since the standard of proof for the attribution of guilt is lower. (This happened in the case of O.J. Simpson, who was first acquitted in a criminal case and then held liable in a civil case.) It may be that evidence that is admissible in one jurisdiction will be disallowed in another.

We are therefore required to consider the procedures which enable the determination of such questions as who has the burden of proof for each subquestion, whether particular pieces of argument and evidence are admissible, when it is proper to reach a decision, the standard of proof expected for particular subquestions.

Moreover, the facts are not given at the outset of the case. Although there may be points of agreement between the two parties, other facts, and explanatory theories, will emerge and be constructed as the case proceeds.

Acknowledging these observations, AI and Law has in the last fifteen years produced a number of dialogue game models of legal procedure, adapting techniques from so-called 'formal dialectics' in philosophical logic and argumentation theory. This started with Tom Gordon's [17] computational model of a (rationally reconstructed) particular legal procedure, the American procedure of civil pleading. Subsequent work has focussed more on idealised procedures. This AI and law work is similar in style to (mostly later) work in multi-agent systems on modelling dialogues involving argumentation. A recent overview of both strands of work is given in [35]. In addition to this work on dialogue games, there is some work on the role of burden of proof in legal reasoning and legal procedure (e.g. [18], [39] and [43]).

5. Some Important Topics for Investigation

We now discuss what we think are some of the most important current issues in logic and law that we hope will be addressed in this corner (although other issues are, of course, not excluded).

5.1 Representation

Ontologies

A main concern with respect to representation has been the growth of interest in ontologies. So far in AI and Law, the ontologies used have been predominantly thesaurus or taxonomy style ontologies, targeted at applications such as information retrieval and inter-language understanding. Elsewhere in AI, advances have been made in more sophisticated ontologies, formulated in description logics. There seems to be considerable scope for these techniques to be introduced into the legal domain: those norms which serve to define legal concepts would appear to be an ideal subject for description logics. Moreover, in so far as many other norms are concerned with classification into legal concepts, description logics may be of wider application. The role for description logics in logic and law is still largely unaddressed.

Action, time and change; procedures
A recurrent problem in representation in AI is law is the representation of action, time and change: whether we are thinking about changes to the law itself or changes in legal relations consequent upon the actions of the parties concerned. Outside of AI and Law, there are active communities working on logics of action, time and change and it would be interesting to see the fruits of this research applied to the legal domain. Legal and compliance procedures seem particularly suited for formalisation in temporal and action logics, while model-checking techniques might be applied to their formal verification. The highly important topic of regulatory compliance, in particular, is intimately bound up with these issues.

5.2 Reasoning

Reasoning about evidence
Reasoning about evidence is a topic which has had no more than a preliminary exploration thus far. Possible lines of development include: extension of the argument scheme approach for evidential reasoning (for instance, to the handling of statistical evidence); extension of the scenario-based approach; further integration of these approaches and with integration with purely statistical approaches.

Practical reasoning
Practical reasoning is another topic at which the law could profit from active research communities outside the law. The justification of choices made in the course of problem solving has been explored in the context of agent systems. The topic is also important in law and so there is ample scope for the transfer of this work to the legal domain. Other work in the multi-agent system area looks at making choices constrained by social laws. Again this notion of what it is to comply with the law is of relevance to law, in legal planning systems and systems directed at regulatory compliance.

Combining modes of reasoning
Addressing a legal problem typically involves a number of different modes of reasoning: at least evidential reasoning, case-based, classificatory, and sometimes practical reasoning when a choice needs to be made. Integrating these different modes of reasoning and managing the transition from one to another in the course of solving a legal problem is as yet largely unexplored.

Accrual of arguments

Where several arguments for a given claim exist, there are questions of how they should be combined to reflect their collective strength. Since legal arguments, like arguments in many other fields, are often persuasive rather than coercive, situations in which the combined effect of several arguments pro and con a position need to be considered are frequently encountered. In such circumstances the possibility arises that an argument is defeated by several arguments taken together, even though each is individually weaker. The circumstances under which arguments can accrue, and mechanisms to allow accrual are needed to address this problem. Some preliminary attempts to capture accrual exist (e.g. [34]), but there is much more to be done.

Argument schemes
Argument schemes have provided a fruitful way of exploring certain questions, but the approach has by no means exhausted its utility. Work here will include both the detailed exploration of particular schemes and their associated questions, and general exploration of the role of schemes in reasoning and dialogue.

5.3 Interaction

Investigating procedures for resolving conflicts and disputes
As indicated above, AI and Law has modelled procedures for resolving conflicts and disputes for many years Such models have been formal to greater and lesser extents, but even in the more formal cases little attention has been paid to proving their properties, for example whether the procedure is guaranteed to terminate, or whether it gives a 'fair' opportunity to the parties to express their own and attack the other parties' views. In other fields there is more systematic investigation of procedures. For example, in the context of multi-agent systems procedures for auctions, negotiation and voting have been extensively studied. Such work provides a good model for the more rigorous investigation of models of legal procedure. Fully formalising procedures in action languages (as in e.g. [6]) provides an example of how legal procedures for dispute resolution might be modelled in a way more amenable to formal investigation of their properties. (Of course, all this also applies to the above-discussed more specific legal and organisational procedures.)

Rational behaviour within disputes
Since legal reasoning often occurs in procedural settings and the aim of reasoning within a procedure is to persuade the other participants, the principles of legal reasoning include interactive strategies as an important element. Hardly any work has been done so far in AI and Law on persuasive dialogue strategies (one exception applying game theory is [41]) and so there are good opportunities to apply techniques from game theory and other relevant fields.

6 Conclusion

We have argued that there is ample opportunity to apply techniques from computational logic to the law, and we have discussed a number of particular such opportunities. The list of topics we gave above, however, is by no means intended to be exhaustive. There are many other topics in logic and AI which could make a contribution to AI and Law. One attraction that the legal field holds is that it is a rich

source of realistic examples. A real advantage is that the reasoning used in legal examples is more extensively recorded than in many other fields.

The law is a domain where the cognitive and interactive turns in logic are especially prevalent. The application of logic to law should therefore provide mutual benefits: insight into legal reasoning and how to make it computational, as well as a real and challenging test bed for logical techniques. We see this corner as an ideal venue for this interchange.

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