An Ontology for the Construction of Legal Decision Support Systems

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Abstract

In this paper we discuss how we have used an adaptation of Toulmin's theory of argumentation to develop an ontology for the construction of legal knowledge-based systems. Our ontology has been developed into a knowledge management tool ArgumentDeveloper. We also discuss five systems we have constructed using ArgumentDeveloper.

1. Introduction

[Zeleznikow and Hunter 1994] in their treatise on how to build intelligent legal information systems discuss the relevant sources of law. They claim that the following four sources are the major tools for legal decision-making:

1) Statutes – a formal written enactment of a legislative body which declares, commands or prohibits something;

2) Treatises – a scholarly work discussing an important issue;

3) Precedents – an adjudged case or decision of a court considered as furnishing an example or authority for an identical or similar case afterwards or a similar question of law. In common law countries (such as England and Ireland) courts attempt to decide cases on the basis of principles established in prior cases;

4) Textbooks - .

[Gruber 1995] defines an ontology as an explicit conceptualisation of a domain. [Bench-Capon and Visser 1997] examine the development of legal ontologies. Ontologies have benefits for

a) Knowledge sharing;

b) Verification of a knowledge base;

c) Knowledge acquisition and

d) Knowledge reuse

[Visser 1995] builds a formal legal ontology by developing a formal specification language that is tailored in the appropriate legal domain. Visser commenced by using [Van Kralingen 1995]'s theory of frame-based conceptual models of statute law. Visser uses the terms ontology and specification language interchangeably. He claims an ontology must be:

1) epistemologically adequate;

2) operational;

3) expressive;

4) reusable; and

5) extensible

Visser chose to model the Dutch Unemployed Benefits Act of 1986. He created a CommonKADS expertise model [Schreiber *et al* 1999]. Specifying domain knowledge is performed by:

i) Determining the universe of discourse by carving up the knowledge into ontological primitives. A domain ontology is created with which the knowledge from the legal domain can be specified.

ii) Domain specification is created by specifying a set of domain models using the domain ontology.

[Valente 1995] developed a legal ontology based on a functional perspective of the legal system. He considered the legal system as an instrument to change or influence society in specific directions by reacting to social behaviour. The main functions can be decomposed into six primitive functions each of which corresponds to a category of primitive legal knowledge

a) Normative knowledge – which describes states of affairs which have a normative status (such as forbidden or obligatory);

b) World knowledge – which describes the world that is being regulated, in terms that are used in the normative knowledge, and so can be considered as an interface between common-sense and normative knowledge;

c) Responsibility knowledge – the knowledge which enables responsibility for the violation of norms to be ascribed to particular agents;

d) Reactive knowledge – which describes the sanctions that can be taken against those who are responsible for the violation of norms;

e) Meta-legal knowledge – which describes how to reason with other legal knowledge.

f) Creative knowledge – which states how items of legal knowledge are created and destroyed.

Valente's ontology, which he described as a Legal Information Server, allows for the storage of legal knowledge as both text and an executable analysis system interconnected through a common expression within the terms of the functional ontology. The key thrust of his conceptualisation is to act as a principle for organising and relating knowledge, particularly with a view to conceptual retrieval.

The Dutch Tax and Customs Administration have developed the POWER (Program for an Ontology-based working environment for rules and regulations) research project ([van Engers and Kodelaar 1998] and [van Engers and Glasee 2001]. POWER develops a method and supporting tools for the whole chain of processes from legislation drafting to executing the law by government employees. The POWER program improves legislation quality by the use of formal methods and verification techniques.

At the Donald Berman Laboratory for Information Technology at La Trobe University, we have focussed upon building legal decision support systems. Our systems have been built in conjunction with Victoria Legal Aid (VLA). VLA is a statutory, non-government body concerned with providing legal support to the indigent. Since VLA does not bill either by the hour, or even by each individual case, it is most concerned about being efficient. About 60% of its labour is devoted to assessing whether applicants are eligible for legal aid. Clearly, it would be preferable if VLA lawyers spent their time providing clients with legal aid, rather than assessing clients for grants. To meet this need, we have developed a web-based system GetAid [Stranieri and Zeleznikow 2001a], which advises solicitors and their clients as to whether the client is eligible for legal aid

The development of our legal decision support systems has also led to:

(i) enhanced consistency in decision-making;

(ii) a better community understanding of the domain, also leading to less public criticism of judicial decision making[1]; and

(iii) enhanced support for dispute resolution, since users of the system will be aware of the likely outcome of litigation and thus be encouraged to avoid the costs and emotional stress of legal proceedings.

1 Judges of the Family Court of Australia are worried about criticism of the court which has led to the death of judges and physical attacks on court rooms. They believe enhanced community understanding of the decision making process in Australian Family Law will lead to reduced conflict.

With the advent of web-based legal decision support systems, access to legal knowledge has greatly increased

2. Representing and reasoning with domain knowledge

At the Donald Berman Laboratory we have been involved in the construction of the following legal decision support systems [Zeleznikow and Stranieri 2001]:

1) Property Division in Australian Family – Split_Up

2) Refugee Law – EMBRACE [Yearwood and Stranieri 1999]

3) Copyright of Computer Software – RightCopy

4) Sentencing of criminals

5) Eligibility for Legal Aid

In building these systems we have developed an ontology for structuring knowledge for the constriction of legal decision support systems. We have constructed such systems by:

1) Developing techniques for extracting domain knowledge;

2) Deciding upon inferencing techniques

3) Providing explanations for the decisions reached by the appropriate system.

To extract domain knowledge, we commence by reading the sources of the relevant law. This includes legislation, cases, treatises and books.

We then interviewed domain experts. For our systems these included academics, family lawyers, mediators, judges, Refugee Review Tribunal members, software engineers, intellectual property lawyers, public defenders, criminal law barristers and VLA grants officers.

For each of the five systems mentioned above, we then used a jurisprudential theory based on both open texture and boundedness to decide upon the appropriate inferencing techniques [Zeleznikow 2000]. Inferencing we have used includes: rules, neural networks, weighted sum formulae, fuzzy reasoning and association rules. The following table summarises the techniques used:

System	Application	Reasoning Techniques Used
IKBALS	Workers Compensation	Rule-based reasoning and case-based reasoning
CAAS	Credit Law	Rule-based reasoning and case-based reasoning. Rule induction was used to learn factors about closest

		factors
Split-Up	Family Law Property Distribution	Rule-based reasoning and neural networks. Explanations are provided in ArgumentDeveloper.
Family_Negotiator	Family Law Negotiation	Rule-based reasoning and case-based reasoning
Embrace	Refugee Law	Rule-based reasoning and information retrieval
GetAid	Eligibility for Legal Aid	Uses rule-based reasoning and ArgumentDeveloper. Is placed on World Wide Web
RightCopy	Informs software developers of their copyright entitlements	Uses rule-based reasoning and ArgumentDeveloper
Sentencing Information System	Provides advice to VLA lawyers on possible sentences for criminals	Uses rule-based reasoning and ArgumentDeveloper.
Family_Winner	Family Law Negotiation	Rule-based reasoning, case-based reasoning and fuzzy cognitive maps

Whilst CAAS, Family_Negotiator, Family_Winner and IKBALS were developed at the Donald Berman Laboratory, they are not the focus of this article.

3. ArgumentDeveloper – a legal knowledge management shell

[Toulmin 1958] concluded that all arguments, regardless of the domain, have a structure which consists of six basic invariants: claim, data, modality, rebuttal, warrant and backing. Every argument makes an assertion based on some data. The assertion of an argument stands as the claim of the argument. Knowing the data and the claim does not necessarily convince us that the claim follows from the data. A mechanism is required to act as a justification for the claim. This justification is known as the warrant. The backing supports the warrant and in a legal argument is typically a reference to a statute or a precedent case. The rebuttal component specifies an exception or condition that obviates the claim.

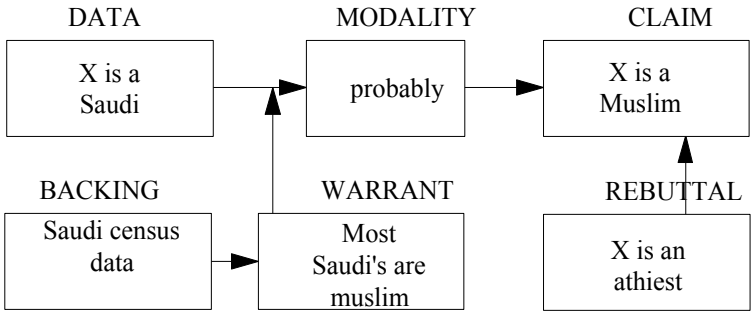

Figure 1 Toulmin argument structure

A survey of applications of the Toulmin Structure has revealed that the majority of researchers do not apply the original structure but vary it in one way or another. Figure 2 illustrates the structure representing the variation used in Split Up. The rationale for the variations applied are described in [Stranieri *et al* 2002].

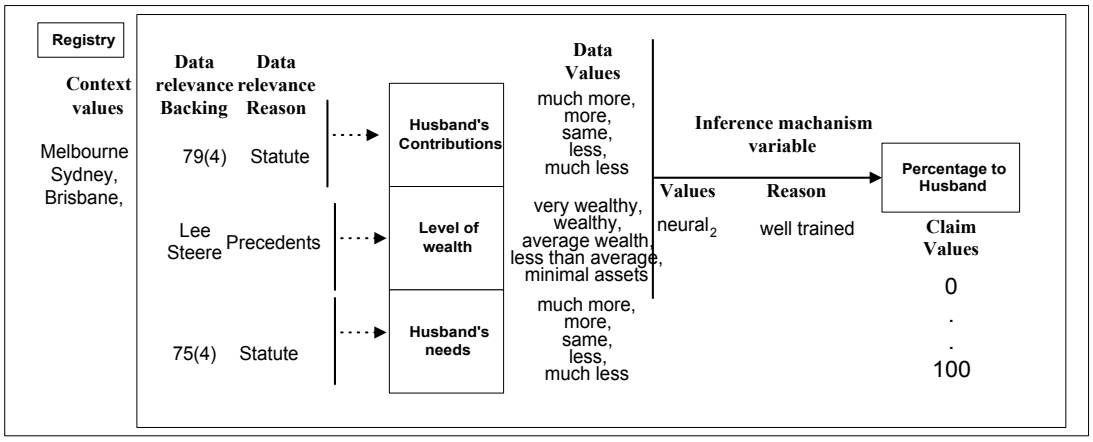

Figure 2. Generic argument for percentage split of assets to the husband

Figure 2 illustrates one argument from the Split Up system. We see from that figure that there are three data items. Each of these are the claim items of other arguments leading to a tree of arguments where the ultimate claim of the system is the root of the tree.

A key difference in our variation from the original is the specification of an inference mechanism variable. In the argument in Figure 2, the inference mechanism is a neural network. The network, once trained with appropriate past cases, will output a claim value (% split of assets) given values of the 3 data items.

In 20 of the 35 arguments in Split Up, claim values were inferred from data items with the use of neural networks whereas heuristics were used to infer claim values in the remaining arguments. The neural networks were trained from data from only 103 commonplace cases. This was possible because each argument involved a small number of data items due to the argument based decomposition.

The Split Up system produces an inference by the invocation of inference mechanisms stored in each argument. However, an explanation for an inference is generated after the event, in legal realist traditions by first invoking the data items that led to the claim. Additional explanatory text is supplied by reasons for relevance and backings. If the user questions either data item value, she is taken to the argument that generated that value as its claim.

The Split Up system performed favorably on evaluation, despite the small number of samples. Currently, the tree of arguments is being modified in conjunction with domain experts from Victoria Legal Aid to accommodate recent changes in legislation. The

argument based representation facilitates the localization of changes and makes maintenance feasible.

The use of the argument based representation of knowledge enables machine learning techniques to be applied to model a field of law widely regarded as discretionary. The legal realist jurisprudence provided a justification for the separation of explanation from inference.

GetAid

The generic / actual framework has recently been applied to acquire knowledge regarding decisions made by officers of VLA, in assessing whether an applicant should receive legal aid or not. Applicants for legal aid must pass three tests. The first, a means test involves a straightforward application of a formula. The second involves satisfying a set of guidelines that stipulate conditions such as types of matters that may be funded. The third, called a merits test, involves a prediction about the likely outcome of the case in Court. Grants officers who have extensive experience in the practices of Victorian Courts assess the merits test. This assessment involves a considerable degree of discretion.

GetAid was programmed using PHP (server-side scripting language) for deployment on the Internet. The program is recursive in nature and dynamically creates HTML pages. Software updates are mainly performed by modifying the database, as opposed to program code, due to the generic nature of algorithms implemented.

The GetAid system was motivated by the view that although there was considerable scope for rule based advisory systems to continue to become prevalent on the web, there was a need for a shell architecture that enabled the development of systems that dealt with open texture. Furthermore, we expected that a shell that could be applied to develop systems that were consistent with legal positivism, realism or both jurisprudence approaches was more likely to have wider application than a shell that only encoded rules.

The resulting shell integrates a rule based reasoning approach with argumentation structures similar to those used in the Split Up system. A new formalism was developed so that the overhead of a rule based inference engine could be avoided. The resulting shell, called WebShell is described in [Stranieri and Zeleznikow 2001a].

RightCopy

The regulation of copyright in e-commerce presents significant legal, technological and social challenges. Commentators on the future of copyright law in cyber space disagree on the extent to which copyright law can remain appropriate in a digital environment. Some authors (e.g. [Stallman 1994]) advocate an overhaul of existing copyright principles. Others, (e.g. [Dixon and Self 1994]) claim that very little change is needed at all. Existing copyright principles are, by and large, adequate for the digital age though minor adjustments are required. Although most governments are implementing minimal change [Stefik 1994], [Richter and Chicola 1999] express concerns that the public interest

aspects of copyright laws, typically implemented as fair use exceptions to authors rights are being eroded. Works locked with public key encryption are totally inaccessible by unauthorized users unless the key is cracked. This is so difficult that it remains virtually possible for an unauthorized user to gain access to a digital work even if the intended purpose underpinning the access is a legitimate fair use exception under copyright law.

Jurisprudence theories do not clearly provide insight for the development of practical systems in this area of law because it is changing so rapidly. To appreciate the changing nature of the law in the context of cyberspace we turned to the general concepts of regulation advanced by [Lessig 1999]. He claims that the regulation of any activity comes about due to law, social norms, economic forces or natural barriers. [Lessig 1999] identifies four types of mechanisms that regulate social behaviour: the law, market forces, social norms and natural phenomena. A simple example illustrates these mechanisms. Motor vehicle speed along suburban streets may be regulated using the law by the implementation of an ordinance that sets a maximum speed, appropriate signage to inform drivers, speed detection mechanisms and appropriate penalties for offenders. Motor vehicle speed may also be regulated with the installation of speed humps. In this case, no ordinance needs to be passed, no signage is needed and penalties are not relevant as the humps provide a natural barrier to speed. Similarly, the regulation of individual smoking could be realised by a legislative ban on smoking.

Natural barriers are proficient mechanisms for regulation. As [Lessig 1999] points out there is no need for laws prohibiting the theft of skyscrapers because of the physical impossibility of stealing a building. In the physical world natural barriers such as humps on roads or un-moveable buildings are typically obvious. In cyberspace, natural barriers are implemented by software and are not so obvious. [Lessig 1999] uses an example about chat rooms organised by a large, global internet service provider. The number of participants in a chat room is regulated by software that admits users up to the maximum number and displays a message inviting others to try later. The regulation of participants in chat rooms using software restricting access is not as transparent as it would be if the regulation was implemented with laws, market incentives or social norms.

The formulation by [Lessig 1999] motivated our search for a technological device that could helps to ensure fair use principles. [Stranieri and Zeleznikow 2001b] propose an agent based knowledge based approach to help regulate copyright. Five knowledge-based systems are described that are sufficiently flexible to protect authors rights without denying the public access to works for fair use purposes. The architecture involves the use of an agent-oriented approach. The owner of a work and users who wish to copy a portion of the work are participants in the discursive community and share the same generic arguments. In order to copy the work users constructs their own actual arguments. The agent representing the owner determines whether to release the work or not by constructing its own actual argument. The generic / actual framework simplifies the negotiation protocol and assists in the deployment of an agent oriented approach

To date the argument structure has been trialed in systems in family law (35 arguments), refugee law (200 arguments), sentencing (23 arguments), copyright law (50 arguments) and eligibility for legal aid (8 arguments).

Current research involves the development of an argumentation shell for this structure (ArgumentDeveloper), and a web based tool for placing Legal Knowledge Based Systems on the World Wide Web [Stranieri and Zeleznikow 2001a]. ArgumentDeveloper is being designed as an agent oriented program with discourse agents committed to engaging other agents in a dialogue so as to model how arguments rebut, extend or support others.

Once the decision support systems have been built we then convene a committee of experts to evaluate and validate the argument structure (see [Stranieri and Zeleznikow 1999] and [Hall and Zeleznikow 2001]).

4. Conclusion

At the commencement of our research at the Donald Berman Laboratory for Information Technology and Law, in 1990, we were interested in using artificial intelligence techniques to build legal decision support systems. We used a variety of strategies, and had no underlying methodology. Our desire to work in discretionary domains, and the need to use knowledge discovery techniques, led us to focus upon argumentation. Our reliance upon Toulmin's theory of argumentation led us to structure knowledge in a specific manner and to build ArgumentDeveloper, a knowledge management tool for structuring legal knowledge in the form of Toulmin Arguments.

We have recently formed a not for profit company JUSTSYS, with aim of commercialising both WebShell and ArgumentDeveloper. We already have contracts to develop GetAid and Split-Up.

As part of the POIROT project, the Joseph Bell Centre for Forensic Statistics and Legal Reasoning will attempt to extend this work by developing forensic ontologies in the domain of financial fraud. Our eventual aim is to build computer tools, which will support the prevention, detection and prosecution of crime and criminals.

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