SPLIT-UP: A WEB-BASED LEGAL DECISION SUPPORT SYSTEM THAT ADVISES UPON THE DISTRIBUTION OF MARITAL PROPERTY

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SUMMARY: I. *Introduction*. II. *Jurisprudential Theories Behind the Construction of the Split-up System*. III. *The Split-up System*. IV. *GETAID*. V. *Conclusion*. VI. *References*.

I. INTRODUCTION

I was sitting in my first year college/undergraduate chemistry class,[1] when Neil Armstrong said the famous words "One small step for man, one giant leap for mankind". These words were uttered as man first stepped on the moon.

The moon-landing project was highly motivated by a president who has been dead for forty years.[2] After over twenty-five years of no moon landings,[3] a new president, George Walker Bush has declared man will again land on the moon, two years before I am due to retire as a college professor.[4]

1 On 25 July 1969.

2 John Fitzgerald Kennedy was assassinated on November 22 1963. As the song says "the good they die young". Or, is it only those who die young are remembered as being good?

3 And US military involvement in Vietnam, Afghanistan (twice) and Iraq (twice).

4 President George W. Bush has declared the US will next place a man on the moon in 2013 and soon after will have man land on Mars.

Progress in the use of intelligent legal decision support systems has also been slow. Further, the failure to utilise such systems often has no relationship to the technical qualities of the system. They have more to do with user interfaces, money and organisational support. As [Jackson 1990] states, as with the utilisation of most management information systems, two of the most critical factors in the successful use of expert systems are: a champion in management; and user involvement and training.

Nevertheless, [Susskind 2000] believes such systems will be regularly used in legal practice. He outlines the past use of Information Technology (IT), and indicates probable future uses of IT by the legal profession. He indicates that until recently, there was only limited use of IT by legal professionals. Whilst the use of word processing, office, automation, case management tools, client and case databases, electronic data/document interchange tools and fax machines is now standard, only recently have legal firms commenced using knowledge management techniques. The use of applied legal decision support systems is in its infancy.

The development of intelligent systems in legal practice was investigated by (Zeleznikow and Hunter 1994). They noted that most commercially successful systems have employed rules. The major reasons for this occurrence include that it is easy to model rules and there are many tools for building rule-based systems.

Although many commentators including (Moles and Dayal 1992) clearly express reservations about this approach for the majority of fields of law, rule-based reasoning is still the predominant basis for legal decision support systems. The fundamental limitation not addressed by this view of law can be reduced to two significant omissions: (a) the failure to model open texture, and (b) the failure to provide an analysis of how justification differs from the process used to arrive at decisions.

1. *Rule Based Decision Support Systems*

There are many knowledge representation techniques. Logic is particularly useful in the domain of automated theorem prov-

ing, which can trace its roots to the work of Newell and Simon in the early 1960's (Newell and Simon 1972). The earliest legal knowledge based systems were developed in the 1970's; they were primarily rule- or logic-based.

The JUDITH system (Popp and Schlink 1975) used rules to represent part of the German Civil Code. Their rules were very similar to those developed in the Mycin system (Shortliffe 1976).

Logistic regression and basic nearest neighbour methods were used in (McKaay and Robilliard 1974) to support case based retrieval to predict judicial decisions. They did not develop a model of legal reasoning; their domain was that of Canadian capital gain cases in the decade 1958-1968.

Two different kinds of rules were used in (Meldman 1977): general rules which define the elements of the claim, and specific rules extracted from cases. Things and relations are used to represent the *everyday world of human affairs* and are classified hierarchically into categories. A fact comprises two things and a relation between them; facts are assembled into situations. These situations are compared with the situation of the instant case, and the system determines the extent to which the instant case falls within or near the law of intentional torts (for example assault and battery).

TAXMAN was a logic-based deductive reasoner concerned with the taxation of corporate organizations. McCarty chose that domain because he believed the corporate tax domain is primarily *a tidy world of formal financial rights and obligations*. TAXMAN I [McCarty 1977] used an entirely rule based model. TAXMAN II [McCarty 1980] proceeded beyond the scope of rule-based systems by attempting to deal with open-textured concepts such as *continuity of interest*, *business purpose* and *step transactions*. It represented legal arguments as a sequence of mappings from a prototypical case to a contested case, in an attempt to perform analogical reasoning. Instead of adding cases to the knowledge base, open textured concepts were repre-

sented using a prototype —a concrete description expressed in the lower level representation language— together with a sequence of deformations or transformations of one concrete description into another.

In developing TAXMAN II, McCarty noted:

— Legal concepts are open textured;
— Legal rules are dynamic as they are applied to new situations they are constantly modified to *fit the new facts*;
— In the process of theory construction there are plausible arguments of varying degrees of persuasiveness for each alternative version of the rule in each new fact situation, rather than in a single correct answer.

TAXADVISOR (Michaelsen and Michie 1983) used EMYCIN to assist lawyers in estate tax planning. It collected data about clients and suggested strategic plans about various aspects such as life insurance, retirement schemes, wills and making gifts and purchases. Rather than provide statutory interpretation, TAXADVISOR uses lawyers' experience and strategies to produce plans.

The British Nationality Act as a Logic Program (Sergot *et al*. 1986) uses logic programming to perform statutory interpretation upon the British Nationality Act of 1981. The data needed for individual cases is stored in the APES shell. The answers produced by APES are the logical consequences of the rules together with supplied information. The knowledge in the rules is represented in and/or graphs.

Whilst the system is an interesting application of logic, the paper is jurisprudentially flawed, because it believes that law is straightforward and ambiguous. For example, the authors claim that a statement as to whether *an infant was born in the United Kingdom* is a readily verifiable fact. But is this statement true?

The boundaries of the United Kingdom are both constantly changing an in dispute. When the system was developed in

1986, if a child was born in Hong Kong, was she born in the United Kingdom under the Act?[5] At that time, Hong Kong citizens had British citizenship, but not the right of abode in the United Kingdom. Are the Falkland Islands (or Malvinas to others), part of the United Kingdom? These issues cannot be determined by reference to the Act or precedents. They depend on International Treaties, and even more significantly, delicate negotiations.

ExperTAX (Shpilberg *et al*. 1986) was developed by Coopers and Lybrand to provide advice to clients of United States' certified public accountants on how to conduct the tax accrual and tax planning functions. The system improves staff accountants' productivity, the quality of information provided to them and accelerates their training process.

Ernst and Young UK developed three legal expert systems: VATIA (Susskind and Tindall 1988), Latent Damage Adviser (Capper and Susskind 1988) and THUMPER (Swaffield 1991). VATIA (*V*alue *A*dded *T*ax *I*ntelligent *A*ssistant) placed specialist Value Added Tax expertise in the hands of auditors. VATIA enabled auditors to carry out overviews of clients' VAT affairs.

The Latent Damage Adviser modelled the Latent Damage Act 1986. The problems solved by the Latent Damage Adviser presented few difficulties for latent damage experts, but proved difficult for non-experts because they are not familiar with the complex web of inter-related rules that constitute this area of law. Susskind claims the statute was poorly drafted, complex and *barely intelligible*.

THUMPER was developed for use by corporate tax practitioners at Ernst and Young who give advice about tax liability and planning in respect of stamp duty. THUMPER has a three-layer conceptual model:

5 On June 30 1997, Hong Kong was returned to China.

— Outermost level – users' view of the problem;
— Middle level – expert's interpretation of the principles and legislation of stamp duties; and
— Innermost layer – represents the legislation and the case law. The case law is stored in the form of rules induced by the experts from the cases.

SoftLaw Corporation Limited is an Australian company that provides software solutions for the administration of complex legislation, policy and procedure. SoftLaw's product —STATUTE Expert— is a knowledge base management system specifically designed for administrative rules.

SoftLaw has a comprehensive software project management methodology, which provides the following tools to software teams:

A) A document process model, which outlines all procedures and the products to be developed during the life of a project;
B) Templates for producing documentation on all issues to be considered at each step in the process; and
C) A team model, which ensures representation of all perspectives in the team.

Many Government agencies administer complicated legislation, policy or processes. Agencies structure their work organization, budget and level of client service around managing this complexity. The traditional management approach uses high numbers of specialized in-house staff, trained in individual aspects of an agency's work.

SoftLaw can create a rule base model of any complex legislation, policy or process. This makes the source material accessible to generalist users. STATUTE Expert guides a user through the rule base, and advises on the right course of action.

Law firms interpret and apply legislation to give advice to businesses and individuals. STATUTE Expert models complex

legislation and rules and removes the experience of complexity for the user. With STATUTE Expert, lawyers can provide online advice on procedural law, supported by comprehensive legal reasoning. They can work effectively and quickly with unfamiliar legislation. Routine work can be done by non-specialists and generalists. Costs to a firm and to clients can be reduced.

Government regulation affects every business. Regulatory regimes are often complex, costly and burdensome for businesses, which want to meet their obligations as simply and cheaply as possible. Regulatory agencies have conflicting interests. Their policy is to target their regulations precisely and maximize the level of compliance. They also want to meet the needs of the businesses they regulate and the industry groups that pressure them to reduce the burden of compliance.

Using rulebase technology, Softlaw has created tools that remove most of the complexity from regulations, helping industry to comply quickly, easily and reliably. The use of rulebase technology has several benefits:

— reduced complexity,
— ease of compliance,
— reduced compliance costs, and
— improved levels of compliance.

SOFTLAW is a successful commercial enterprise which provides legal decision support systems for governments in Australia, the United Kingdom and the United States. It is listed on the Sydney (Australia) stock exchange.

2. *Access to Justice*

The Rand Corporation built numerous Expert Systems in the early 1980's (Waterman and Peterson 1984) to advise upon risk assessment. One of their early systems —LDS— assisted legal

experts in settling product liability cases. LDS's knowledge consisted of legislation, case law and, importantly, informal principles and strategies used by lawyers and claims adjustors in settling cases.

Another Rand Corporation decision support system —SAL (Waterman *et al*. 1986)— also dealt with claims settlement. SAL helped insurance claims adjusters evaluate claims related to asbestos exposure. SAL used knowledge about damages, defendant liability, plaintiff responsibility and case characteristics such as the type of litigants and skill of the opposing lawyers.

These two systems are important for they represent early first steps in recognizing the virtue of settlement-oriented decision support systems.

As we note from the work reviewed in this section, most legal decision support systems advise about risks and entitlements rather than predicting the results of litigation.

Whilst there have been many successful intelligent decision support systems used in laboratories, very few could be considered commercial successes. Further, the most useful intelligent decision support systems have been to ensure risk assessment has been ensured.

One of the major benefits of decision support systems that advise upon risk assessment, is that they help avoid litigation. (Ross 1980) states *the principal institution of the law is not trial; it is settlement out of court*. To support this argument, (Williams 1983) notes that whilst the figures may vary in different jurisdictions, of all the cases listed before the courts only about 5% of the cases are ever heard by the court and only 1% of the cases result in judicial decision-making. He quotes the 1980 Annual Report of the Director-Administrative Office of the United States of America Courts, Washington, D.C. (1980) at pages A-28 and A-20 which states that the average percentage of cases reaching trial verdict is 6.5%. The average for districts varies from a low of 2.0% to a high of 16.1%. By circuits, the differ-

ences are less extreme, ranging from a low of 4.0% in the District of Columbia Circuit to a high of 8.4% in the Eighth Circuit.

Further, many disagreements are never even listed before courts. (Ross 1980) claims that a major study of personal injury/automobile insurance cases in the United States shows that of claimants represented by attorneys who obtained some compensation, 72% filed suit, 6.5% started trial and 2% reached a verdict.[6] Obviously these figures will vary depending on the jurisdiction and type of actions, however what does not vary is that negotiated settlements account for the vast majority of all legally binding decisions.

(Katsh and Rifkin 2001) state that compared to litigation, Alternative Dispute Resolution has the following advantages:

A) Lower cost;
B) Greater speed;
C) More flexibility in outcomes;
D) Less adversarial;
E) More informal;
F) Solution rather than blame-oriented;
G) Private

(Zeleznikow and Bellucci 2003) claim that On Line Dispute Resolution has additional benefits:

H) Disputants do not have to meet face-to-face: an important factor if there has been a history of violence;
I) Mediation can occur at any time, with participants located in different countries.

To avoid the risks of extra costs and an unfavourable outcome, disputants often prefer to negotiate rather than litigate. Whilst investigating how disputants evaluate the risks of litigation researchers are faced with a basic hurdle-outcomes are often, indeed usually, kept secret. If the case is litigated, it could

6 Automobile Personal Injury Claims, U.S. Department of Transportation, Automobile Insurance and Compensation Study, 1970.

be used as a precedent for future cases, which may be a disincentive for one or more of the litigants (Goldring 1976). Publicity of cases and the norms resulting from cases makes the public aware of the changing attitudes towards legal issues.[7] The adjudication decision not only leads to the resolution of the dispute between the parties, but it also provides norms for changing community standards (Eisenberg 1976). This latter facet is lost in negotiated settlements.

The secrecy behind negotiated settlements is one of the reasons for the paucity of published material on legal decision support systems dealing with risk. WIRE IQ (Wire Intelligent Quantum) is an Internet delivered decision support system which allows lawyers, insurers and re-insurers access to up-to-the minute quantitative analysis of current claims settlement values for a wide range of personal injuries (Douglas and Toulson 1999). (Douglas and Toulson 1999) state that analysis and price discovery of tort in un-settled personal injury claims has been conducted using rule-based systems. In such systems, the details of the claim (injury type, claimant's age, sex, earnings, etcetera.) are entered into the system. The system then applies predefined rules to determine the settlement value of the claim.

WIRE IQ uses a database with thousands of records of settled claims and court wards for a range of personal injury claims. It then provides the following analysis services based on the data: trend analysis, comparative analysis, precedent search and forecasts. The forecasts are performed using neural networks.

JNANA (www.jnana.com) was founded in 1995 as Counselware, with the aim of building decision support systems for lawyers. The company very quickly realised that there was a large commercial need for decision support systems that advise upon

[7] In common law countries, changing community values towards issues such as abortion, euthanasia and rape within marriage have been enacted in the legal system through landmark precedents, rather than parliamentary legislation.

risk assessment. Such systems are not made available to the public. JNANA currently focuses upon building a software platform to enable advice to be deployed over the Internet and Intranet. JNANA is now being used broadly in many industries, such as financial services, health care, customer relationship management, legal, and regulatory compliance.

(Branting 2001) notes that increasing numbers of litigants represent themselves in court. This swelling tide of *pro se*[8] litigants constitutes a growing burden not only to the judiciary but the entire legal process. Typically, unrepresented litigants:

— Extend the time taken for litigation – due to their lack of understanding of the process.
— Place themselves at a disadvantage compared to their opponent(s).
— Place the judicial decision-maker in the difficult position of deciding how much support and forbearance the decision-maker should offer to the *pro se* litigant.

(Quatrevaux 1996) notes that there is a shortfall in legal systems for poor persons in the United States. (Branting 2001) claims that domestic abuse victims are particularly likely to have few resources and little opportunity to obtain the services of a lawyer. He states that the growth of the consumer movement has increased the trend for *pro se* litigation. The growing availability of books, document kits and computerised forms, together with the increasing availability of legal materials on the World Wide Web, has increased the opportunities for *pro se* litigants to organise their own litigation.

When considering decision making as a knowledge-manufacturing process, the purpose of a decision support system is to help the user manage knowledge. A decision support system ful-

[8] A *pro se* litigant is one who does not retain a lawyer and appears for himself in court.

fils this purpose by enhancing the user's competence in representing and processing knowledge. It supplements human knowledge management skills with computer-based means for managing knowledge. A decision support system accepts, stores, uses, receives and presents knowledge pertinent to the decisions being made. Its capabilities are defined by the types of knowledge with which it can work, the ways in which it can represent these various types of knowledge, and its capabilities for processing these representations.

Over the past ten years the Donald Berman Laboratory for Information Technology and Law has built a variety of legal decision support systems, covering the domains of:

A) Worker's Compensation (Zeleznikow 1991).
B) Credit Law - IKBALS (Zeleznikow *et al* 1994).
C) Family Law Property Division - Split-Up (Stranieri *et al* 1999).
D) Refugee Law - EMBRACE (Yearwood and Stranieri 1999).
E) Family Law Negotiation – (Bellucci and Zeleznikow 2001).
F) Copyright Law - RightCopy (Stranieri and Zeleznikow 2001a).
G) Eligibility for Legal Aid - GetAid (Stranieri and Zeleznikow 2001b).
H) The Sentencing of Criminals (ongoing).

Table 1 illustrates decision support systems developed at the Donald Berman Laboratory for Information Technology and Law during the last decade.

Table 1
Legal Decision Support Systems built at the Donald Berman Laboratory for Information Technology and Law

System	*Application*	*Reasoning Techniques Used*	*Status*
IKBALS I	Workers Compensation	Rule-based reasoning and case-based reasoning.	Abandoned due to change of legislation in 1992.
CAAS	Credit Law	Rule-based reasoner.	Used in back office of the Bank of Melbourne until 1995.
IKBALS III	Credit Law	Rule-based reasoning and case-based reasoning. Rule induction was used to learn factors about closest cases.	Solely a research prototype.
Split Up	Family Law Property Distribution	Rule-based reasoning and neural networks. Separate argumentation shell developed.	Prototype first version used privately by mediators, judges lawyers. Web-based second version is being developed for use by VLA.
Family-Negotiator	Family Law Negotiation	Rule-based reasoning and case-based reasoning.	Used solely to understand the domain of family mediation.
Embrace	Refugee Law	Rule-based reasoning and information retrieval.	Policy changes by a new government have meant the system is only used as a training tool.
GetAid	Eligibility for Legal Aid	Uses sequenced transition networks Argument Developer. Is placed on World Wide Web.	The commercial success story!!! Is being used by VLA to provide on-line advice re eligibility for Legal Aid.
RightCopy	Informs software developers of their copyright entitlements	Uses sequenced transition networks and Argument Developer.	SEA, our industry partner has chosen not to commercialise the system.
Sentencing Information System	Provides advice to VLA lawyers on possible sentences for criminals	Uses sequenced transition networks Argument Developer.	Under current development.
Family-Winner	Family Law Negotiation	Rule-based reasoning, case-based reasoning and fuzzy cognitive maps.	Under current development.

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

(i) Consistency – by replicating the manner in which decisions are made, decision support systems are encouraging the spreading of consistency in legal decision-making.

(ii) Transparency – by demonstrating how legal decisions are made, legal decision support systems are leading to a better community understanding of legal domains. This has the desired benefit of decreasing the level of public criticism of judicial decision making[9].

(iii) Efficiency - One of the major benefits of decision support systems is to make firms more efficient.

(iv) Enhanced support for dispute resolution - Users of legal decision support systems are aware of the likely outcome of litigation and thus are encouraged to avoid the costs and emotional stress of legal proceedings.

Whilst we do not claim that the construction of legal decision support systems will have a drastic effect on improving access to justice, we make the argument that the construction of such systems for community legal centres will improve their efficiency and increase the volume of advice they can offer. Until recently, most legal decision supports systems were rule-based and developed to run on personal computers. Whilst personal computer based tools are fine for lawyers, they may not be easily accessible to pro-se litigants. Reasons for this difficulty include their lack of an awareness of such systems, and the high cost of purchasing relevant software. Currently, very few legal decision support systems are available on the World Wide Web.

The Australasian Legal Information Institute (AustLII www.austlii.edu.au) provides free internet access to Australian legal

[9] 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 courtrooms. They believe enhanced community understanding of the decision making process in Australian Family Law will lead to reduced conflict.

materials. AustLII's broad public policy agenda is to improve access to justice through better access to information. To that end, AustLII has become one of the largest sources of legal materials on the net, with over seven gigabytes of raw text materials and over 1.5 million searchable documents. AustLII publishes public legal information that is, primary legal materials (legislation, treaties and decisions of courts and tribunals) and secondary legal materials created by public bodies for purposes of public access (law reform and royal commission reports for example). It does not have any decision support systems on its internet site.

The British and Irish Legal Information Institute (BAILII-www.bailii.org) provides access to the most comprehensive set of British and Irish primary legal materials that are available for free and in one place on the internet. CanLII (www.canlii.org), now a permanent resource in Canadian Law, was initially built as a prototype site in the field of public and free distribution of Canadian primary legal material.

In this paper, we consider the development of the Split-Up system. Split-Up offers advice upon property distribution following divorce in Australia. It is currently being used in universities, the offices of Victoria Legal Aid and a variety of barristers and solicitors. Technical details regarding the Split-Up system have been discussed in detail in (Stranieri 1998) and (Stranieri *et al* 1999). A detailed description of legal principles behind the development of the Split-Up system can be found in (Zeleznikow 2004).

II. Jurisprudential Theories Behind the Construction of the Split-up System

The Split-Up project aims to examine how to model the exercise of discretion in legal decision-making. In doing so, we have developed jurisprudential theories which suggest we may wish to apply knowledge discovery from database (KDD) processes to law.

1. *Knowledge Discovery from Databases*

According to (Fayyad *et al* 1996) knowledge discovery from databases is the "non trivial extraction of implicit, previously unknown and potentially useful information from data". Knowledge discovery techniques have not been applied extensively in the legal domain despite potential benefits in the automated generation of legal knowledge from data. The absence of data in quantities collected in other fields such as astronomy accounts, in part, for this trend. However, for the most part, KDD has not been extensively performed with legal data because of a lack of clarity about how this can be achieved.

Theories of jurisprudence have proved indispensable for the analysis and development of computational models of legal reasoning. For example, the rule positivism of (Hart 1961) underpins the application of logic programming in law exemplified by (Sergot *et al* 1986). The identification of jurisprudential theories that are particularly applicable to improve KDD in law and how they can be applied, is primary objective of this research project.

KDD techniques, in general can be grouped into four categories:

A. *Classification.* The aim of classification techniques is to group data into predefined categories. For example, data representing important case facts from many cases may be used to classify a new case into one of the pre-defined categories, "pro-plaintiff" or "pro-defendant".

B. *Clustering.* The aim of clustering techniques is to analyze the data in order to group the data into groups of similar data. For example, a clustering technique may group cases into six main clusters that which an analyst would interpret in order to learn something about the cases.

C. *Series Analysis.* The aim of series analysis is to discover sequences within the data. Sequences typically sought are time series. For example, past cases over a time period may

be analyzed in order to discover important changes in the way a core concept is interpreted by Courts.

D. *Association.* The objective of association techniques is to discover ways in data elements are associated with other data elements. For example, an association between the gender of litigants and the outcome of their cases may surprise analysts and stimulate hypotheses to explain the phenomena.

(Zeleznikow *et al* 1994) in (IKBALIII) used rule induction to generate indices into cases. Rule induction was used by (Rissland and Friedman 1995) to analyse a domain in order to detect a change in the way a legal concept is used by Courts. Large numbers of cases were examined by (Wilkins and Pillaipakkamnatt 1997), who used the ID3 algorithm in order to estimate the number of days that are likely to elapse between the arrest of an offender and the final disposition of the case.

A State Supreme Court Judge in Brazil (V. Feu Rosa Pedro) has initiated a program for the resolution of traffic accident disputes (FeuRosa 2000). His 'Judges on Wheels' program involves the transportation of a judge, police officer, insurance assessor, mechanical and support staff to the scene of minor motor vehicle accidents. The team collects evidence, the mechanic assess the damage, and the judge makes a decision and drafts a judgement with the help of a program called the Electronic Judge before leaving the scene of the accident.

Although KDD with data from law is not prevalent, important examples of classification, clustering, series analysis and association have been performed. See (Stranieri and Zeleznikow 2004) for further details.

In practice, a knowledge discovery from database process involves the incorporation of some domain expertise at each of the following KDD phases: data selection, pre-processing, transformation, mining and evaluation. According to argumentation theorists, domain expertise can conveniently be represented as argu-

ments for or against assertions. Therefore, we surmised that argumentation may provide a convenient framework for the representation of domain expertise when performing Knowledge Discovery from Databases.

2. *Open Textured Legal Domains*

(Berman and Hafner 1988) indicate that legal reasoning is essentially indeterminate because it is open textured. (Bench-Capon and Sergot 1988) view the indeterminacy in law as a specific consequence of the prevalence of open textured terms. They define an open textured term as one whose extension or use cannot be determined in advance of its application. (Prakken 1997) collates and analyses the substantial artificial intelligence literature on open texture to point out that situations that characterise law as open textured include reasoning which involves defeasible rules, vague terms or classification ambiguities. This analysis of open texture is central to our discussion because we argue that the existence of judicial discretion is a form of open texture that is distinct from the situations considered by (Prakken 1997). The distinct types of situations that (Prakken 1997) notes are difficult to resolve because of the open textured nature of law are:

A) *Classification difficulties.* (Hart 1958) presents a local government ordinance that prohibits vehicles from entering a municipal park. He argues that there can be expected to be little disagreement that the statute applies to automobiles. However, there are number of situations for which the application of the statute is debatable. What of roller blades, for instance? (Fuller 1958), in a response to Hart posed the situation of a military truck mounted in the park as a statute. Considerable open texture surrounds the use of the term 'vehicle' in this case even though there is no question that the truck is a vehicle.

B) *Defensible rules.* Another type of open texture arises from the defeasibility of legal concepts and rules. Any concept or rule, no matter how well defined, is always open to rebuke. Rarely do premises or consequents exist in law that are universally accepted. Whilst a Victorian statute definitively prohibits drink-driving, few courts would convict a person who was forced to drive drunk at gunpoint. The rule, in this case is defeated in the context of exceptional circumstances.

C) *Vague terms.* Legal tasks are often open textured because some terms or the connection between terms are vague. A judge finds the various interpretations of terms such as reasonable or sufficient stems from the vagueness of these terms and not from classification dilemmas or defeasibility requirements. (Brkic 1985) labels this a gradation of totality of terms that he claims is one reason that deduction is an inappropriate inferencing procedure for many problems in law.

The existence of judicial discretion contributes to the open textured nature of law. Yet situations that involve discretion cannot be described as instances of classification difficulties, defeasible rules or the presence of vague terms. We thus argue that the existence of discretion is a distinct form of open texture.

Consider a hypothetical panel of Family Court judges who agree on all the facts of a family law property dispute. Members of the panel can conceivably arrive at different percentages of the assets that ought to be awarded to the wife. The different outcomes may partly be due to the presence of vague terms that are interpreted differently by various judges. In part, the different outcomes may be due to classification type anomalies. One judge classifies a lottery win as a contribution to the marriage whereas another does not. Different outcomes may even be the result of defeasible rules. One judge applies the principle of an asset-by-asset approach, whereas another considers that principle irrelevant and adopts the global approach.

While these scenarios describe situations that are open textured, there is another situation, common in family law cases

that are not captured by these instances of open texture. A panel can be imagined where vague terms are interpreted in much the same way by all judges. There are no classification anomalies and all judges have used the same principles. In this scenario, the outcomes may still be different because judges apply different weights to each relevant factor. No judge is wrong at law, because the statute clearly affords the decision-maker precisely this sort of discretion. Thus, an additional situation is apparent; one where the decision-maker is free to assign weights to relevant factors, or combine relevant factors in a manner of his own choosing. This discretion will certainly contribute to the open textured nature of law and to indeterminacy.

(Dworkin 1977) presents a systematic account of discretion by proposing two basic types of discretion, which he called strong and weak discretion. Weak discretion describes situations where a decision-maker must interpret standards in his own way whereas strong discretion characterises those decisions where the decision-maker is not bound by any standards and is required to create his or her own standards. (MacCormick 1978) does not dispute this conceptualisation but contends that Dworkin's distinction between typologies is one of degree and not of type. The discretion apparent in Australian family law exemplifies the weak discretion of Dworkin. The vast majority of decisions made by the Family Court of Australia does not introduce new standards, set new precedents nor invoke a new factor that has not previously been considered. Consequently, the majority of such decisions cannot be seen to involve strong discretion. Most cases are those that (Zeleznikow *et al* 1997) call commonplace cases.

We claim that there are levels of discretion depending on the domain. There are many domains in which the exercise of discretion cannot be explained by the application of rules and principles. We hold this view because there exist domains such as property division in Australian family law, in which two decision makers may be applying identical rules and principles to

facts interpreted in the same way, yet both arrive at different, yet legally valid outcomes. Typically, the statute that underlies these domains presents a list of factors to be considered by the decision-maker, but does not indicate the relative weighting of each factor. (Christie 1986) calls these types of statutes shopping list Acts. Judges, in such domains exercise discretion by assigning a relative importance to each factor. The principle statute governing Australian family law, The Family Law Act (1975) is an example of a shopping list Act.

Under this Act, the sole grounds for dissolution of marriage are an irretrievable breakdown of the marriage. Matrimonial fault was not deemed relevant as the basis for the distribution of property interests by the framers of the Family Law Act (1975). However, the notion of contributions was regarded as suitable. The principle that a party to a marriage should be rewarded for his or her past efforts introduces a retrospective element into the determination of suitable property orders. The retrospective element is counter balanced with a prospective element. The prospective element has been called "future needs". However, this terminology is not indicated in the statute. Section 79(4) and Section 75(2) of the Family Law Act (1975) list a number of factors that must be considered when devising a property order. Section 79(4) refers to the prospective element included in Section 75(2).

The statute presents a "shopping list" of factors to be taken into account in arriving at a property order. The relative importance of each factor remains unspecified and many crucial terms are not defined. For example, the nature of a contribution is left unspecified. What weight the retrospective element assumes relative to the prospective element is similarly left unspecified. The age, state of health and financial resources of the litigants are explicitly mentioned in the statute as relevant factors, yet their relative weightings are also unspecified. The Act clearly allows the decision-maker a great deal of discretion in interpreting and weighing factors.

3. *Levels of Stare Decisis*

According to (Kovacs 1992) family law in Australia differs from other legal domains in that the principle of *stare decisis*, that like cases should be treated alike, is only superficially applied in family law. For example, the Full Bench of the High Court of Australia, determined in Mallet vs. Mallet (1984) 156 CLR 185, that trial judges cannot base their assessment of property matters by assuming a 50/50 split between husband and wife and deviating from this starting point on the basis of contributions and needs. Trial judges are encouraged by the High Court to take all factors indicated in the statute into account.

(Kovacs 1992) contends that the High Court in Mallet vs. Mallet failed to take the opportunity to place specific constraints on the way in which trial judges determine property matters. (Ingleby 1993) largely concurs with the views of (Kovacs 1992). He notes that an appeal to the first appellate Court, the Full Bench of the Family Court of Australian is not permitted if the only ground for appeal is that the appeal court would have arrived at a different result had it heard the case. Permissible grounds for appeal include:

A) the first instance judge did not include reasons for a discretionary decision,
B) the trial judge acted on a wrong principle,
C) the trial judge allowed irrelevant matters to guide him or her,
D) the trial judge did not take relevant matters into account or did not afford them appropriate weight,
E) the trial judge mistook the facts.

Stare decisis is a fundamental principle in common law legal systems. The principle dictates that the reasoning, loosely, *ratio decidendi*, used in new cases must follow the reasoning used by decision-makers in courts at the same or higher level in the hierarchy.

Thus, if for instance, fields of law such as property division in Australian family law are so discretionary that leading commentators convincingly argue that stare decisis does not apply, then can case outcomes be accurately predicted? If outcomes cannot be accurately predicted, then any attempt at modeling techniques is futile.

Perhaps outcomes in discretionary fields cannot be predicted because the discretion that is inherently placed in the hands of the judge encourages so much uncertainty that predictions can only ever be educated guesses. However, if this were the case, we would expect practitioners in Australian family law to be consistently inaccurate with their own predictions. On the contrary, we find that practitioners are very accurate in predicting outcomes, despite the discretion available to judges. This apparent paradox is resolved by looking more closely at the concept of *stare decisis*.

(Wassestrom 1961) identifies three types of *stare decisis*. Under *traditional stare decisis*, a court is bound by prior decisions of courts of equal or higher level. It is this kind of *stare decisis* that (Kovacs 1992) and (Ingleby 1993) claim has not occurred fully in family law, because the High Court has failed to lay down specific constraints for trial judges to follow.

Another type of stare decisis, called *personal stare decisis,* is used to describe the observation that most judges attempt to be consistent amongst themselves. This manifests itself in the Family Court, as the tendency that an individual judge has to be consistent with the way he or she exercised discretion in past, similar cases.

The third type of stare decisis, *local stare decisis*, represents the tendency of a group of judges that make up a current court to follow its own decisions. Local *stare decisis* manifests itself in property division in Australian family law, as a desire for Family Court judges to exercise discretion in a manner that is consistent with other judges of the same registry of the Court, at the same time. This may occur because the decision makers all share the same values.

(Lawler 1964) claims that predicting the outcome of a case is impossible without the concept of *stare decisis*. Furthermore, the ability to predict an outcome with some accuracy is important if the law is to be both transparent and consistent.

Despite constant controversy about Australian Family Law property division, by and large, experienced practitioners can predict outcomes with some degree of accuracy. As (Kovacs 1992) and (Ingleby 1993) point out, this level of predictability is not due to traditional *stare decisis*. We take the view that the predictability must be the result of the remaining two forms of *stare decisis*, local and personal *stare decisis*.

This has ramifications for the data selection, data pre-processing and evaluation phases of Knowledge Discovery from Databases (KDD). Some case outcomes in discretionary domains are so far removed from other similar cases that it is reasonable to assume the judge has erred. In domains characterised by traditional *stare decisis*, a judge can err by failing to follow the constraints laid down by superior or equal Courts. In domains characterised by personal and local stare decisis, judges err by failing to be consistent with other judges currently in the same registry of the Court or with themselves.

Another ramification of local and personal *stare decisis* relates to the types of cases suitable for the data selection phase. (Ingleby 1993) argues that the vast majority of cases that come before the Family Court are not extraordinary. They do not involve extraordinary facts, do not have outcomes that are unexpected and are, consequently rarely reported by Court reporting services. (Zeleznikow *et al* 1997) calls such cases commonplace cases and distinguishes them from landmark or leading cases. In fields where traditional *stare decisis* is emphasised, any case that is currently viewed as commonplace could be used in the future as a landmark case. This blurs the distinction between landmark and commonplace cases. However, in domains where traditional *stare decisis* is not strongly followed, if a case is regarded as commonplace at the time of decision, it is extremely unlikely to

be invoked in the future as a landmark case. An ordinary case impacts by adding to the body of cases for personal and local *stare decisis*.

Our conceptualisation of traditional, local and personal *stare decisis* also has ramifications relating to the way in which we evaluate explanations generated by computer systems that use knowledge from a KDD process. In domains characterised with traditional *stare decisis*, reasons for a first instance decision often involve principles laid down by appellate Courts. In the absence of traditional *stare decisis*, explanations cannot be rigidly derived from principles, because appellate Courts have specifically failed to lay down such principles. Explanations must necessarily be further removed from the sequence of reasoning steps used to infer an outcome.

In building the Split-Up, system we have not used legal principles or rules to model the way judges actually combine factors to arrive at a decision. Rather, what judges have actually done in deciding real cases is assimilated by machine learning techniques so that a sub-symbolic representation of the exercise of discretion is established. Our starting point for the process, is an identification of factors that are currently, or have, in the past been relevant in the determination of a property outcome. Once relevant factors have been identified, data mining algorithms can learn to weight factors. (Christie 1986) and (Bayles 1990) analyse jurisprudential assumptions that must be made regarding the concept of discretion in order to adopt the approach used here.

III. The Split-up System

In the Split-Up project (Stranieri *et al* 1999) we wished to model how Australian Family Court judges exercise discretion in distributing marital property following divorce. Section 79 (1) of the *Family Law Act (1975)* empowers the Family Court to make orders altering the property interests of parties to the mar-

riage but does not lay down procedural guidelines for judicial decision makers. In practice, judges of the Family Court follow a five-step process in order to arrive at a property order:

1. Ascertain the property of the parties.
2. Value all property of both parties.
3. Determine which assets will be paramount in property considerations. This is referred to as common pool property.
4. Determine a percentage of the property to be awarded to each party.
5. Create an order altering property interest to realize the percentage.

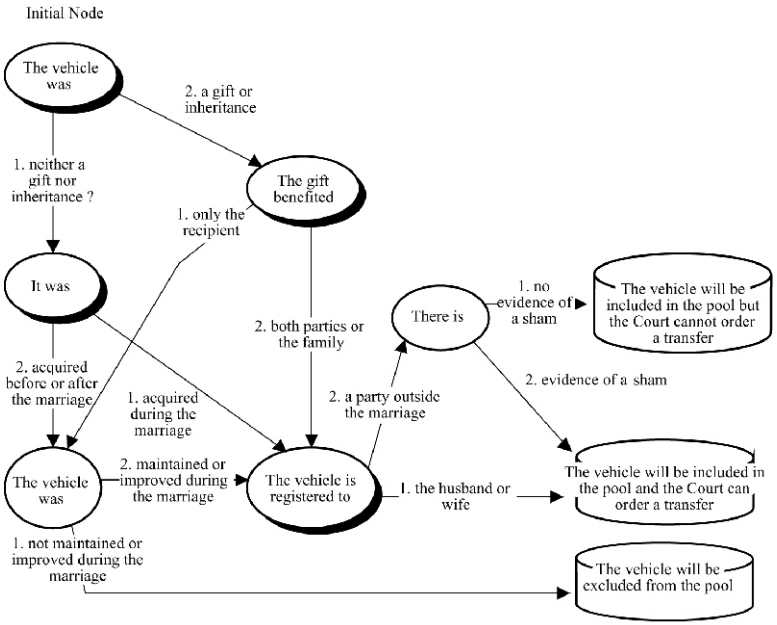
The Split-Up system implements steps 3 and 4 above, the common pool determination and the prediction of a percentage split. According to domain experts, the common pool determination task (Step 3) does not greatly involve the exercise of discretion, in stark contrast to the percentage split task (Step 4). Consequently, Split-Up implements the common pool determination by eliciting heuristics as directed graphs from domain experts using a methodology we have called sequenced transition networks.

1. *Sequenced Transition Networks*

A decision tree is a directed graph in which the nodes represent domain concepts and possible values for each concept are captured in arcs emerging from each node. Leaf nodes represent conclusions. (Stranieri and Zeleznikow 2001) introduced a variation on the conventional decision tree. They labeled nodes and arcs in a pre-specified manner which allowed for their conversion into sets called sequenced transition networks (STN). The sets are stored as tuples in a relational database. The STN methodology aims to reduce but not eliminate the involvement of a knowledge engineer and thus lessen the knowledge acquisition

bottleneck that hinders rule based expert system development. Using the STN methodology, experts are able to effortlessly build and maintain their own rule sets without being familiar with expert system shell environments, rule syntax or programming languages. Figure 1 represents knowledge about whether a vehicle is considered marital property.

Figure 1
Sequenced Transition Network that determines
if an automobile is in the Common Pool

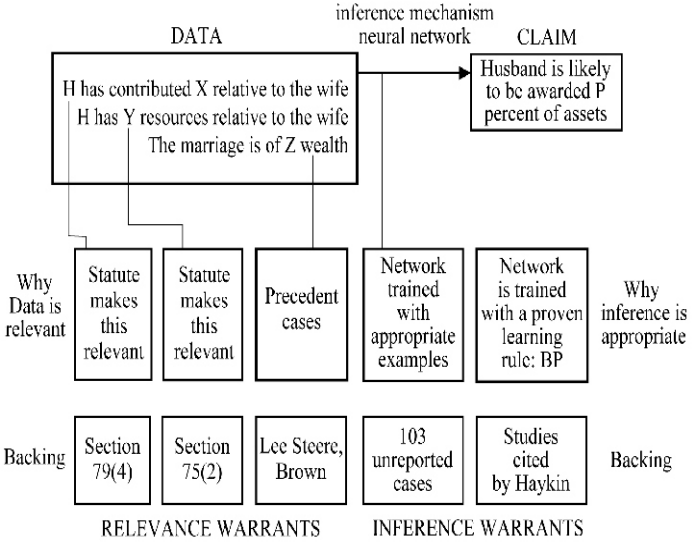


The common pool property determination component of Split-Up was modelled using 51 sequenced transition networks containing 230 nodes. A detailed description of how to model legal decision-making using sequenced transition networks, and the use of sequenced transition networks in building web-based decision support systems can be found in (Stranieri and Zeleznikow 2001c). In the STN approach, there is no requirement to convert graphs to rules because graphs are converted into sets that corresponds to paths through the graph. All paths through a directed graph are currently transferred to a relational database manually but development is in progress to automate this so that an expert need only draw a graph in order to produce a system that represents procedural knowledge.

2. *Argument Trees*

Domain expertise in family law is represented in the Split-Up system as arguments. This enables an informed data transformation phase and also constrains the data mining. For the philosopher (Toulmin 1958), practical reasoning, as distinct from analytical reasoning involves the construction of an argument. 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 that argument. A warrant justifies why the claim follows from the data. 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. The Toulmin argument structure has been used by a number of researchers in various fields to model reasoning. However, a survey by (Stranieri *et al* 2001) illustrates that the majority of researchers vary the structure to suit their particular use. The variation that we used aimed to facilitate Knowledge Discovery from Databases. The structure is illustrated in Figure 2.

Figure 2
Toulmin argument structure for one of the Split-Up arguments

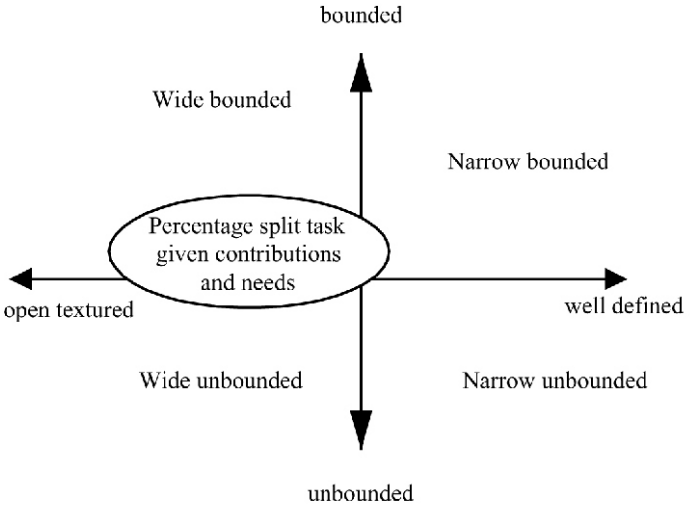


Our variation on Toulmin's theory of argumentation does not include either modality or rebuttal. Whilst these are important components of legal disputation, it was not felt worthwhile to include these invariants, given the programming difficulties involved in representing them.

The problem of deciding whether a legal task can be modeled by any existing paradigm, and if so, which one, is a problem currently tackled in an ad hoc manner by developers of legal reasoning systems. In an attempt to instill some method within our decision-making, we developed a simple classification scheme to classify sub-tasks in Split-Up (Stranieri *et al* 1999). The classification scheme is based on two dimensions. These

are our estimation of the extent to which a task is open textured, and our estimation of the extent to which a task displays a feature that we call boundedness. The scheme illustrated in Figure 3 has two dimensions: open texture well defined and bounded-unbounded.

Figure 3
Classification of percentage split task



The open textured well-defined axis reflects the extent to which experts believed factors known to be relevant in a prediction were open textured. Predicting a percentage split of marital assets was considered open textured by experts because of the high degree of discretion given to judges. The bounded dimension refers to an expert's beliefs about the completeness of their knowledge of relevant factors. In Split-Up, ninety-four variables were identified as relevant for predicting a percentage split of assets. Experts were of the view that few factors useful for a

prediction were omitted from this list and therefore considered the task to be quite bounded.

Tasks that fall in the narrow bounded quadrant are well suited to implementation with heuristics elicited as rules because all terms are well defined and all variables relevant for the prediction are known. Discretionary tasks that fall in the wide bounded quadrant (top left in figure 3) can be modeled using the KDD process.

Unbounded tasks, whether or not they contain open textured terms, cannot be modeled adequately using KDD, since sufficient relevant factors cannot be determined. (Zeleznikow 2000) describes such domains as unfettered discretionary domains. Such domains have no norms and judges are not even told what factors must be taken into account in reaching a decision. We do not believe it is wise to model such domains.

An example of unfettered discretion is the determination of the custody of children in Australian Family Law. According to the Family Law Act (1975) the only factor to be taken into account is *the paramount interests of the child*. Following considerable litigation and uncertainty the Australian Federal Parliament made minimal attempts to define what are the paramount interests of a child. They did this by identifying in the legislation factors such as education, health, the child's relationship with both parents, and the need to keep siblings together. But there is no clear list of factors. Indeed it is much easier to describe what is not in a child's best interests (for example sexual abuse, violence) than what is in a child's best interests. The granting of refugee status can also be considered to be an example of unfettered discretion and is an unbounded domain.

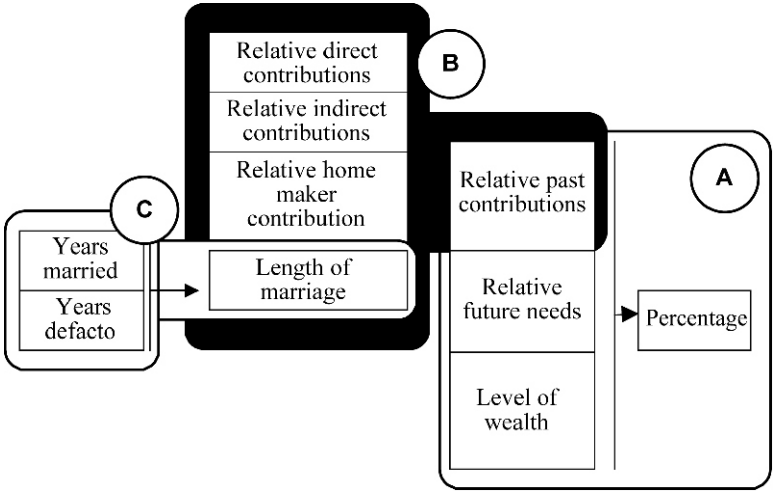
The *Family Law Act (1975)* directs a decision maker to take into account the past contributions of each party to a failed marriage in addition to their resources for coping with life into the future. Rather than offering one definition for *contributions* and one for *needs*, the statute presents a "*shopping list"* of factors to

be taken into account in arriving at a property order. For example, the age, state of health and financial resources of each partner, are explicitly mentioned in the statute as relevant factors, yet their relative levels of importance are unspecified.

Although the statute presents a flat list of relevant factors without specifying how these factors relate to each other, we realised that the factors could be placed in a hierarchy. The development of the hierarchy required specific knowledge supplied by domain experts. A sophisticated hierarchy of ninety-four factors presented in Figure 5 was elicited. Figure 5 demonstrates that the factors relevant for a percentage split determination (extreme right of figure) are past contributions of a husband relative to those of the wife, the husband's future needs relative to those of the wife, and the wealth of the marriage. The factors relevant for a determination of past contributions are the relative direct and indirect contributions of both parties, the length of the marriage and the relative contributions of both parties to the homemaking role. No attempt is made in Figure 5 to represent the way in which relevant factors combine to infer factors higher in the hierarchy. The hierarchy of Figure 5 provides a structure that was used to decompose the task of predicting an outcome into thirty-five sub-tasks. Outputs of sub-tasks further down the hierarchy are used as inputs into sub-tasks higher in the hierarchy. Solid arcs in Figure 5 represent inferences performed with the use of rule sets whereas dashed arcs depict inferences performed using neural networks (or indeed any other KDD technique).

Cases that set a precedent and change future decision-making (landmark cases) were discerned from commonplace cases. This distinction helps us to select cases that are most appropriately used to discover patterns of discretion in typical cases and not those that result in a change in law.

Figure 4
Data and claim for three arguments in Split-Up



To collect data for the Split-Up system, we read Family Court judgements. Values for relevant factors were extracted from each case. Many examples were contradictory. Contradictory examples are those that display different outcomes given the same or very similar inputs. In non-legal domains these are often attributed to noise as erroneously recorded data. However, in discretionary domains of law, we expect some contradictions because individual judges have some latitude to weigh the relevant factors in their own way. There are a number of different ways to deal with contradictions. Most simply, the contradictions can be ignored. (Wang and Gedeon 1995) note that a small proportion of noisy examples will not dramatically effect the performance of a neural network. In law, outcomes that contradict others may reflect judicial error and warrant removal from the

database. Although this is subjective, we adopt the strategy of removing cases that domain experts consider erroneous. A metric to gauge the extent of similarity in inputs of multiple examples with the same outputs was developed in order to facilitate this.

According to data mining rules of thumb, the number of examples needed to identify useful patterns from ninety-four variables is in the many tens of thousands. Data from this number of cases is rarely available in the legal domain. Furthermore, few cases involve all ninety-four variables (*e.g.* childless marriages have no values for all variables associated with children) so a training set would be replete with missing values. We used the Toulmin structure depicted above to decompose the task into smaller tasks each of which involved a sufficiently small number of variables in order to facilitate KDD with the small number (103) of examples we had. Furthermore, the structure enabled the collation of training sets with no missing values. Figure 4 illustrates the claim and data item of three arguments. The claim of argument B was one of the data items for argument A. In total, the ninety-four variables were dispersed in thirty-five arguments. Twenty of these were classified "wide bounded" so training sets were assembled for KDD. Heuristics for the remaining fifteen (classified narrow bounded) were sourced from experts for rule sets.

Split Up is on line at http://www.ballarat.edu.au/~astranieri/splitup/splitup.php

The classification scheme has been used to classify tasks in the domain of family law (Zeleznikow and Stranieri 1995) (35 arguments), refugee law (Yearwood and Stranieri 1999) (200 arguments), copyright law (Stranieri and Zeleznikow 2000) (50 arguments), eligibility for legal aid (Hall and Zeleznikow 2002) (8 arguments) and the evaluation of eye-witness evidence (Bromby and Hall 2002).

3. *Web-Based Decision Support Systems*

The majority of knowledge-based systems in commercial use have not been designed to execute on the world wide web. There are a number of reasons for this. First of all, few expert systems shells have been developed for web environments. Those developed are typically very expensive and beyond the reach of most user groups. Furthermore, traditional rule based system architectures are not particularly well suited for web based shells. For example, the traditional separation of domain knowledge from control knowledge (see Shortliffe 1976) requires that the inference engine scans large segments of the knowledge base in order to find candidate rules to fire. If both inference engine and knowledge bases reside and execute on the server then the time required for this in a web based knowledge based system, in addition to transmission delays from the client to the server and time required for the resolution of rule conflicts is prohibitive. Furthermore, the opportunity for potentially any number of simultaneous users to access a web based knowledge based system places real constraints on concurrency control mechanisms.

(Huntington 2000) claims that difficulties with the introduction of web based expert systems diminish if shells are designed to execute largely on the client's machine as opposed to the server. Java applets are promoted for this. However the appeal of this approach is diminished because client side shells are difficult to realize in practice. The knowledge base and inference engine components of a knowledge-based system are typically large programs that require substantial resources and time to download. Furthermore, execution on the client side is likely to be limited to users with powerful computers restricting the universality of the approach.

The need for web based knowledge-based systems seems to be increasing. For example, in law, there seems little doubt that the trend toward knowledge based systems that encode large and

complex legislation will continue to a substantial extent due to increased public demand for more transparency and consistency in government decision making alongside with the continuing enactment of increasingly complex legislation. The trend toward increased personalization of information on the web described by (Smyth and Cotter 2000) is certain to demand intelligent systems that execute on the web.

Both the sequenced transition networks and argument structures discussed above, have been implemented in a web-based decision support system tool called JustReason. JustReason has been developed by an Australian start-up company JUSTSYS (www.justsys.com.au) JustReason is an open source, inference engine. JustReason draws on knowledge bases (stored as standard relational database tables) and automatically produces web pages that encode sequence of prompts that guide users to a conclusion.

4. *Evaluating the Split-Up system*

One way to ensure consistency in a legal decision support system, is to conduct a thorough evaluation of the system. Split-Up (Stranieri 1998) has been evaluated in five distinct ways:

A. Domain expert assessment of both the content and structure of the Split-Up knowledge base and the problem solving strategy employed in Split-Up. The factor tree and argument structure used in the percentage split task were viewed positively by both domain experts associated with the project and four independent family law practitioners.

B. Comparison of predictions made by Split-Up with those made by eight lawyers on the facts from the same three cases (Zeleznikow and Stranieri 1997). In two of the three cases all eight lawyers agreed with each other (deviations of 5% either way from the Split-Up determination were deemed acceptable)

and with the system. The third case presented significant controversy. Split-Up awarded the husband 55% of the assets. The lawyer's predictions varied from 20% to 60%. The four lawyers that produced outcomes that varied with the other lawyers and Split-Up assumed that the wife had contributed significantly more than the husband to the homemaker-role. The case facts indicated that hired helpers performed the household duties and child rearing. The developers of Split-Up and some lawyers interpreted these facts as leading to an equal contribution to the homemaker role. On the other hand, four others lawyers assumed the wife made the major contribution because the husband was fully occupied with his medical practice and was therefore unlikely to have the time to supervise household staff. This illustrates an important problem with the use of legal decision support systems *users need to interpret data*. Many disputes are about interpreting data (or facts): for such problems, human input is vital.

C. The use of Split-Up on a new trial case recently concluded in the Family Court of Australia, namely Opie vs. Opie. The case is an unreported 1996 case tried by Justice Brown in the Melbourne registry of the Family Court of Australia (the cases used in the Split-Up system were taken from the Melbourne registry of the Family Court of Australia in the period 1992 through 1994). The marriage lasted 17 years and resulted in two children of ages fourteen and sixteen at the time of the trial. The husband ran a business in the automotive industry, which rarely returned large, profits and no longer exists. The wife primarily worked as the homemaker but often worked part-time in the business. The Common Pool system determined that the total assets for consideration were $108,800. Both are in the mid forties and of good health. The wife is to have custody of the children.

Split-Up determines the percentage split in terms of needs, contributions and the level of wealth of the marriage. For the case of Opie vs. Opie Split-Up determined

a) The marriage is considered to be less than average in wealth.
b) Overall the husband has contributed the same as the wife during the course of the marriage.
c) In the future the husband's needs are less than those of the wife.

From these three determinations, through the use of a neural network, Split-Up determined Mr. Opie should receive 35% of the Common Pool. In her decision, Justice Brown granted Mr. Opie 34.7% of the Common Pool.

a) was inferred through the use of a rule-based system given the value of the Common Pool. Domain experts claim the wealth of a marriage is important as future needs are significant for impoverished marriages but far less important for wealthy marriages, where each partner's needs will be met save for exceptional cases. With regard to contributions, as in b), Split-Up suggested that the husband and wife contributed equally to the marriage. Justice Brown said that given the length of the marriage, the parties should be taken to have contributed equally.

With regards to c), Split-Up suggested that the wife had greater future needs than the husband. The system came to this conclusion because it inferred that the wife's prospects for the future are not so fair as she has poor future employment prospects and few resources. The husband, on the other hand, has fair future prospects, because he has good work prospects and some resources for the future. Justice Brown thought likewise.

D. Current research involves feedback from users in four different categories using Split-Up predictions and explanations. Our research is based on the work of (Buchanan *et al* 1995), which claim that empirical validation with the use of a properly constructed questionnaire is a very useful quantitative indicator of user acceptance. We have used seven lawyers, four registrars, three judges and five lay people to evaluate the system using the quantitative assessment evaluation framework of (Reich 1995).

Split-Up is currently being examined by judges, registrars, mediators and lawyers. When first proposed, it was expected that judges and lawyers would primarily use the system. Our subsequent research has shown our initial expectations as to who would be the main beneficiaries of the Split-Up system, to be inaccurate.

How mediators use Split-Up: mediators in family law input both parties facts, peruse the resultant prediction and then explore the hierarchy of relevant data, warrant and backing factors with the parties in order to inform and educate them. Points of convergence between the two parties become obvious and the scale and loci of compromise are more easily identified.

How lawyers use Split-Up: a lawyer uses the system a number of times with each client to explore hypothetical scenarios. Typical questions that arise are *what difference in outcome is there if I argue that my client performed an equal share of the home maker duties as opposed to arguing that she did most of those duties*? A consultation with the system offers a prediction in both scenarios and assists a lawyer in determining which argument to proceed with. Lawyers are less interested in exploring warrants and backings unless these relate precedents that will be used to substantiate an argument chosen.

How judges distribute marital property and might use Split-Up: judges are required to arrive at an equitable outcome in the shortest amount of time possible. They have no need to educate litigants nor do they particularly need (or want) to evaluate their own judgements. However, they need to reach interim conclusions leading to a final judgement. They often need to interrupt a case for hours or days and then succinctly and quickly remind themselves of the facts and their own interim conclusions. Hence, the only benefit judges will reap from Split-Up, will be a useful tool for structuring their decisions.

How divorcees use Split-Up: divorcees with little knowledge of family law have often been surprised at predictions provided

by the system. They tend to explore all warrants and backings in order to understand the prediction. Ultimately, it is not wise for systems such as Split-Up to be utilised by users with little family law knowledge, since such users cannot identify unusual (or hard) cases. The distinction between easy and cases may be jurisprudentially questionable, in that a case that seems perfectly commonplace today may be subsequently used to fundamentally alter a legal principle (hence becoming a landmark case). However, in practice, the Family Court, on a daily basis, uses the distinction between commonplace and landmark cases, in order to decide which cases are to be published by Court reporting services.

Comparing Split-Up outputs with five written judgements of the Family Court of Australia. These cases were heard in 1995 and 1996 (the cases used in both the Split-Up training and test sets were decided in the three years between 1992 and 1994). This comparison showed that Split-Up inferences were similar to those decided by a judge. Many factors were left implicit in some judgements, which Split-Up currently makes explicit. Some departures displayed by Split-Up from conclusions made in judgements can readily be made by small sample size.

The majority of the evaluation studies of Split-Up focus upon the system's quality. In evaluating knowledge-based systems it is common to distinguish between the quality and the usefulness of the system. A system's quality concerns such aspects as the quality of the system's knowledge base and reasoning mechanism and (in particular) the quality of the system's output when applied to a problem. The system's usefulness instead concerns the effects of using the system in practice. Apart from a few interviews, no vigorous field studies have been conducted. However, anecdotal experience has led us to believe that Split-Up is of assistance in advising mediators and divorcees about possible negotiation stances in Family Law disputes (Zeleznikow and Bellucci 2003), but provides limited support to lawyers and judges.

Current research is focusing on showing that the system is useful.

It is essential to regularly update the Split-Up training sets. When new factors are introduced, we need to redesign the Hierarchy of relevant factors for percentage split determination described in Figure 5 (see this Figure on pages 126-127).

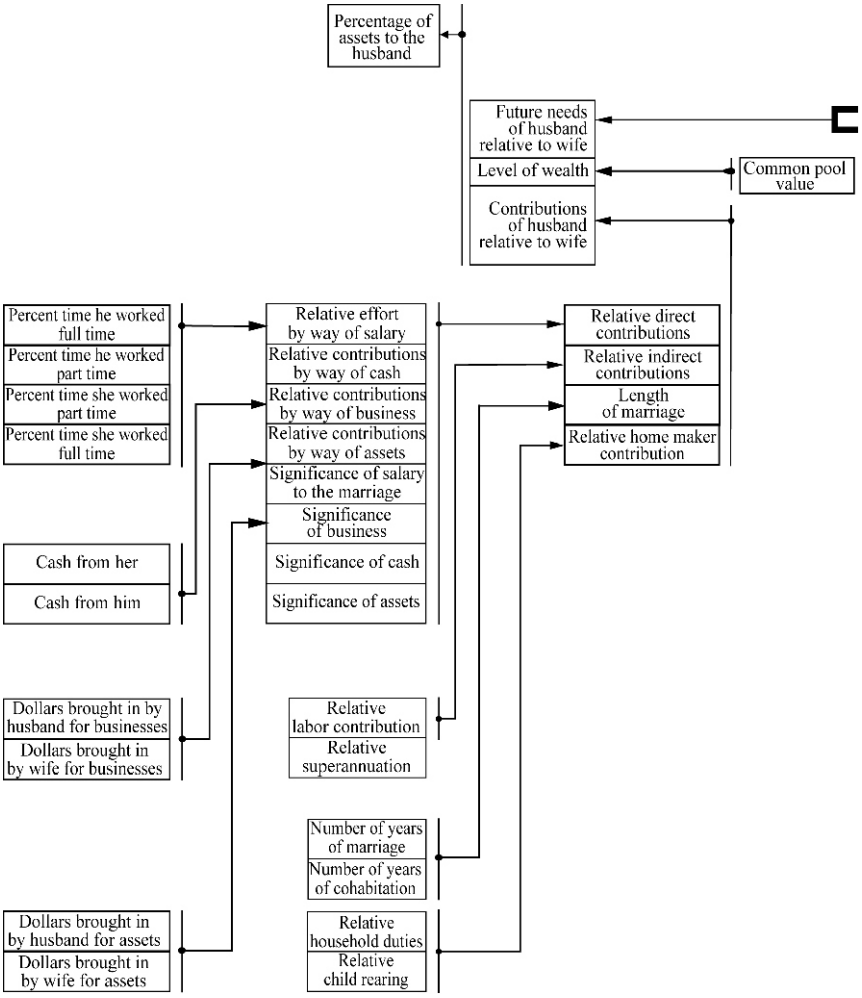
5. *Maintaining and Updating the Split-Up System*

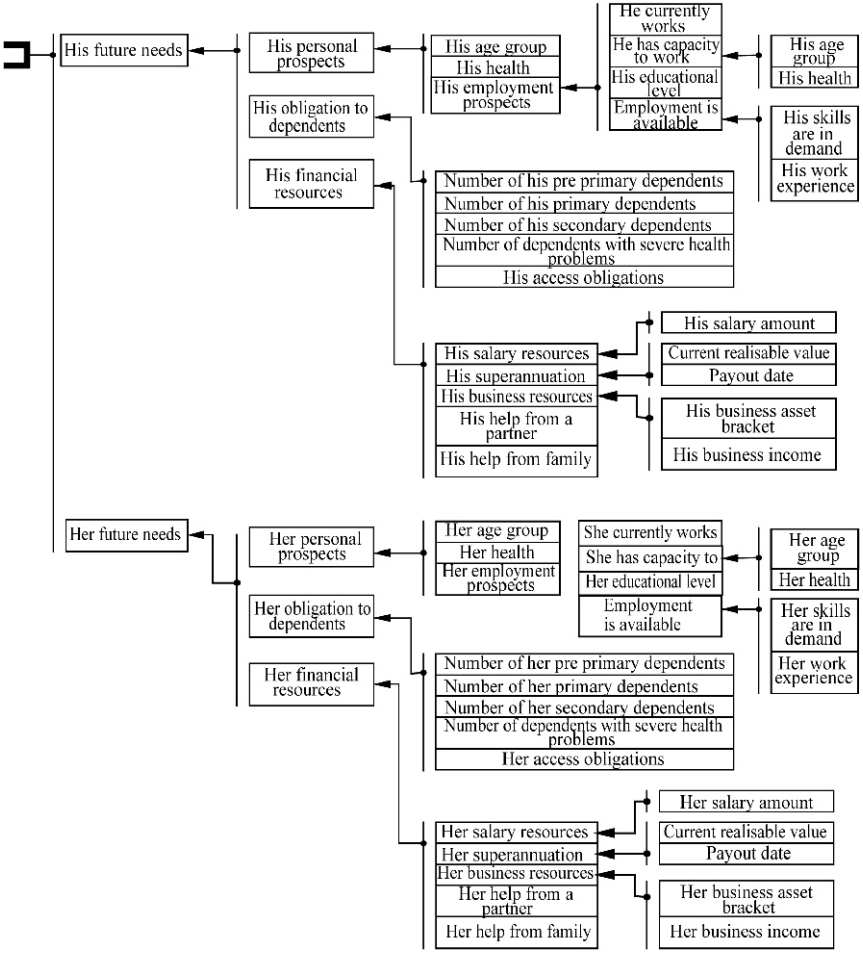
Currently, following the advice of domain experts, the Split-Up system uses ninety-four different attributes. The Split-Up architecture provides no mechanism for determining whether the factors are relevant in empirical terms. It is possible that many of the factors declared relevant by our experts do not, in practice, contribute to a prediction. Thus, a family law prediction could possibly be made with only a subset of the factors regarded as relevant by experts.

We have applied feature selection techniques using genetic search to the data used to determine percentage split in the Split-Up system (Skabar *et al* 1997). We have used genetic algorithms to determine which attributes are essential to model when distributing marital property. Our research shows a more accurate prediction can be made when using sixteen of the ninety-four variables. An interpretation of this result is that Family Court judges when distributing property rarely use the other seventy-eight attributes.

A major problem with the use of rule-based legal decision support systems is the issue of maintaining and updating the knowledge base. Changes in norms through the introduction of new legislation or decisions in landmark cases, can lead to a total re-writing of the rule base.

Figure 5
Hierarchy of relevant factors for percentage split determination





When using cases to build legal decision support systems, if we use landmark cases then we need to give the new landmark cases weights. These weights will depend on the level of the court and how recent decision was made. The estimation of such weights can cause major problems. On the other hand, all commonplace cases carry an equal weight. It is the number of new cases that make a given argument, which proves significant.

So for the top-level Toulmin Argument (part A in figure 4) in the Split-Up hierarchy, landmark cases tell us that in determining the percentage of property awarded to the husband, contributions must be taken into account as well as the level of wealth of the marriage. Legislation (Section 79 [4]) tells us that needs must be taken into account. But only the use of KDD from commonplace cases provides a guide as to how judges balance needs, contributions and the level of wealth of the marriage when determining an equitable distribution of the common pool.

Currently, the Split-Up tree of arguments is being modified in conjunction with domain experts from Victoria Legal Aid to accommodate recent changes in legislation and practice in particular

A) The recent tendency by Family Court judges to view domestic violence as a negative financial contribution to a marriage.
B) The re-introduction of spousal maintenance as a benefit to one of the partners. Under the *clean-break philosophy*, Family Court judges were reluctant to award spousal maintenance, since it would mean one partner would continue to be financially dependant on his/her ex-partner. However the increasing number of short, asset-poor, income-rich marriages has led to a re-consideration of the issue of spousal maintenance.
C) The need to consider superannuation and pensions separately from other marital property.

6. *Split-Up as a Negotiation Support System*

(Ross 1980) states *"The principal institution of the law is not trial; it is settlement out of court"*. Nevertheless, judicial decision-making has a major influence on the outcome of negotiated settlements, because judicial decisions serve as the very basis from which negotiations commence (Williams 1983).

Litigation can be damaging to both parties in a dispute. It is a zero-sum game; in that what one party wins the other loses.[10] Mediation can strive to reduce hostility between the parties, to fashion an agreement about tasks each party is willing to assume and to reach agreement on methods for ensuring certain tasks have been carried out. It can lead to a win-win result.[11]

The Harvard Negotiation Project (Fisher and Ury 1991) introduced the concept of principled negotiation, which advocates separating the problem from the people. Fundamental to the concept of principled negotiation is the notion of *Know your best alternative to a negotiated agreement (BATNA)* the reason you negotiate with someone is to produce better results than would otherwise occur. If you are unaware of what results you could obtain if the negotiations are unsuccessful, you run the risk of: (1) Entering into an agreement that you would be better off rejecting; OR (2) Rejecting an agreement you would be better off entering into.

Whilst Split-Up is not a negotiation support system, it can be used to determine one's BATNA for a negotiation and hence provides an important starting point for negotiations. Split-Up first shows both litigants what they would be expected to be awarded by a court if their relative claims were accepted. It gives them rel-

[10] It is actually worse than a zero-sum game and indeed can often lead to a lose-lose result. This is because of the large legal fees arising from litigation.

[11] For example if both parties value the list of items in dispute, it is not uncommon (as long as they do not value the items in an identical manner) for each party to receive 70% of their requested points.

evant advice as to what would happen if some or all of their claims were rejected. Users are then able to have dialogues with the system to explore hypothetical situations to establish clear ideas about the strengths and weaknesses of their claims.

Suppose the disputants' goals are entered into the system to determine the asset distributions for both parties. For the example taken from (Bellucci and Zeleznikow 2001), the Split-Up system provided the following answers as to the percentages of the marital assets received by each party:

	W's%	*H's %*
Given one accepts W's beliefs	65	35
Given one accepts H's beliefs	42	58
Given one accepts H's beliefs but gives W custody of the children	60	40

Clearly custody of the children is very significant in determining the husband's property distribution. If he were unlikely to win custody of the children, the husband would be well advised to accept 40% of the common pool (otherwise he would also risk paying large legal fees and having on-going conflict).

We are currently investigating developing Split-Up in an On-Line Dispute Resolution Environment.

IV. GETAID

Much of our research has been developed with Victoria Legal Aid (VLA). VLA based in Victoria, Australia is a government-funded provider of legal services for disadvantaged clients (www.legalaid.vic.gov.au). Its goals include providing legal aid in the most effective, economic and efficient manner and pursuing innovative means of providing legal services in the community.[12]

12 As set out in the Legal Aid Act 1978.

VLA focuses much of its attention upon criminal and family law. VLA handles 80% of all Victorian defended criminal cases. This is a great burden on its resources, since Victorian courts require that defendants, who face the possibility of incarceration and do not have the financial resources to hire legal counsel, receive legal representation. Indeed, the Victorian Supreme Court has indefinitely postponed trials in which a defendant has not been represented.[13]

VLA also handles many Family Law disputes. As is the case for criminal matters, applicants for legal aid must meet certain financial guidelines. In addition, they need to be pleading a case that has *a reasonable chance of success*[14]. It is not uncommon for the wife, husband and children in a Family Law dispute to be supported by VLA. One party will receive legal support from VLA; the others will have private lawyers who are paid by VLA. Many prospective VLA family law clients exceed the financial guidelines required for VLA assistance. Since they cannot afford private counsel, they often represent themselves: a very undesirable situation.

When an applicant approaches VLA, his/her application is assessed to determine whether he/she should receive legal aid. This task chews up 60% of VLA's operating budget, yet provides no services to its clients. After passing a financial test, applicants for legal aid must pass a merit test. The merit test involves a prediction about the likely outcome of the case if it were to be decided by a Court. VLA grants officers, who have extensive experience in the practices of Victorian Courts, assess the merit test. This assessment involves the integration of proce-

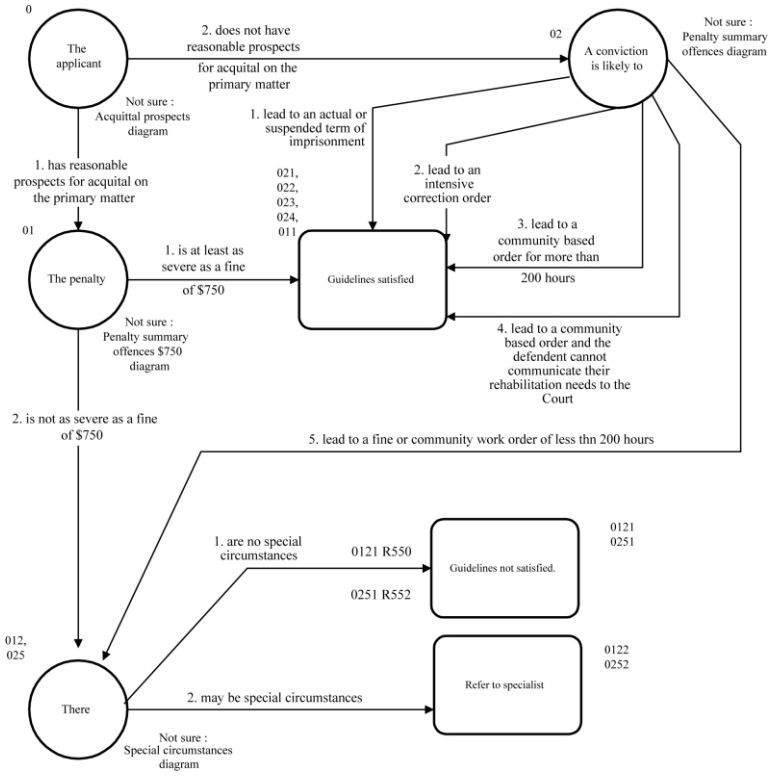
13 In Graham vs. Victoria Legal Aid (2001) VSC 90 (3 April 2001) Supreme Court of Victoria, Criminal Division No. 1496 of 2000, Teague J. made an order that VLA provide legal assistance to Mr. Graham who was held in custody on a charge of murder. In DPP (Cth) vs. His Honour Judge Wodak & Ors (1998) VSC 15 (13 August 1998) considered the case of Mr. Philip Chee Ming Ng. Mr. Ng was arrested in Melbourne and charged with a number of drug offences pursuant to both Commonwealth and State Regulations relating to the importation of heroin into Australia. They decided Mr. Ng should receive Legal Aid.

14 Something which requires legal expertise to ascertain.

dural knowledge found in regulatory guidelines with expert lawyer knowledge that involves a considerable degree of discretion.

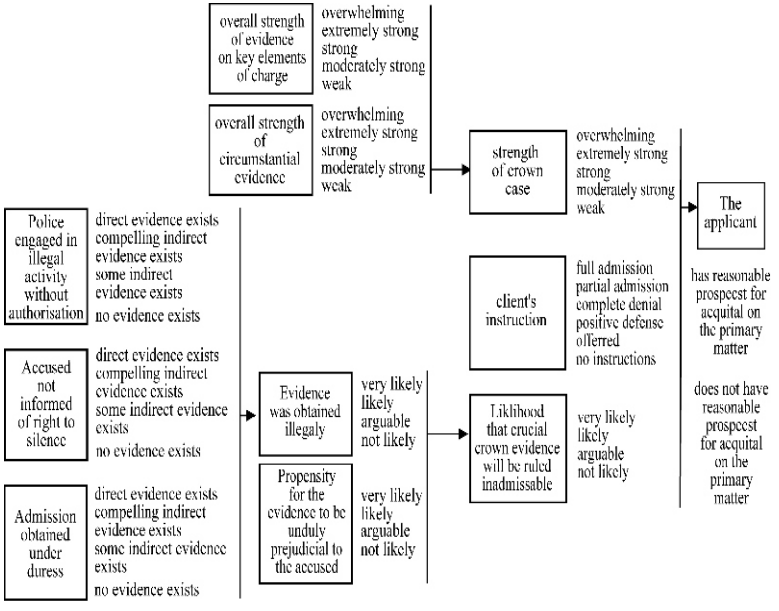
Figure 6 depicts a decision tree that represents reasoning used by VLA lawyers, to determine whether an applicant for legal aid, who is scheduled to appear in a minor (Magistrates) court, has met statutory guidelines.

Figure 6
STN for eligibility for legal aid



Since experts could not readily represent knowledge about an applicant's prospects for acquittal as a decision tree, we decided to model the process as a tree of Toulmin arguments. The first of these is illustrated in Figure 7. In this figure only claim variables/values and data variable/values are included. During knowledge acquisition, the expert is prompted to articulate factors (data items) that may be relevant in determining a prospect for an acquittal claim, without any consideration about how the factors may combine to actually infer a claim value. For every factor presented, a reason for the item's relevance must be given. The next step in the knowledge acquisition exercise using the generic argument is to expand each data item. For example, the expert is asked to describe relevant factors for determining the strength of the crown case.

Figure 7
Argument tree for acquittal prospects



Once the tree is developed as far back as the expert regards appropriate for the task at hand, attention is then focussed on identifying one or more inference mechanisms that may be used to infer a claim value from data item values. It was difficult for the principal domain expert to articulate the ultimate argument (the argument on the extreme right of Figure 7). She could not express her heuristic as rules because the way in which the factors combine is rarely made explicit. Her expertise was primarily a result of the experience she had gained in the domain. Although it is feasible to attempt to derive heuristics, the approach we used was to present a panel of experts with an exhaustive list of all combinations of data items as hypothetical cases and prompt the panel for a decision on acquittal prospects. Six experts and the knowledge engineer were able to record their decision in all of the exhaustive hypothetical cases (for that argument) in approximately 40 minutes. The decisions from each rater were merged to form a dataset of 600 records that were used to train neural networks.

The inference mechanism in JustReason consists of two components: a lookup table for exceptions and a weighted sum formula. Once the user has supplied values for data items, the JustReason inference engine attempts to look up a claim value in the lookup table of exceptions. This table stores values that are exceptions to the weighted sum formula that are detected during the evaluation phase of knowledge based system development. If no entry is found in the lookup table, the inference engine applies a weighted sum formula according to weights associated with each data item. Using a lookup table to store the mapping between data values and claim values also enables the use of inference methods other than neural networks.

Neural network inferences can be implemented by storing all possible data item inputs and corresponding claim value outputs in the lookup table. A real time, web-based implementation cannot rebuild a neural network for each inference without causing consultation delays so storing all inputs/outputs as a lookup table enables fast inferences even when the source was a neural network.

Figure 8
WebShell based on Argument tree

Figure 9
WebShell based on Argument tree

A user consults the GetAid system via the web pages that are generated from the decision tree described above. Suppose a user follows the "Not-Sure" link on the web page depicted in Figure 7. She is taken to a page that presents three user prompts that derive directly from the argument depicted in Figure 7; *strength of the crown case*, *client's instruction* and *likelihood that crown evidence is ruled inadmissible*. This page is illustrated in Figure 8. The user is presented with a consistent user interface throughout and is generally unaware that some pages are generated from the argument tree and others from the decision tree.

The PHP program that implements the argument based inferences is somewhat more complex than the STN but it is still a small and relatively simple program that executes on the server side very quickly and is not memory intensive. The GetAid was tested by VLA experts and developed in conjunction with web-based lodgement of applications for legal aid (Hall *et al* 2002). Since the middle of 2003, Victorian solicitors have been using the GetAid system to ascertain whether their clients are eligible for legal aid.

V. CONCLUSION

Despite the failure of legal professionals to embrace the use of intelligent legal decision support systems, we agree with (Susskind 2000) that they will be regularly used within legal practice in the next domain. We believe such systems have an important role to play in improving access to justice.

We have provided supporting evidence for these beliefs by discussing in detail, intelligent legal decision support systems we have constructed. Split-Up uses knowledge discovery from database techniques to advise upon the distribution of marital property following divorce, whilst GetAid advises upon eligibility for Legal Aid.

Current research focuses upon:

a) Access to justice,
b) Argumentation,
c) Computational models of discretion,
d) Web-based decision support system,
e) Knowledge discovery from legal databases,
f) Negotiation Support and On Line Dispute Resolution.

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